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Deer Habitat Potential of Pine-Hardwood Forests in Louisiana

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SUMMARY

Responses of the understory and overstory plant community to selection tree harvest in an all-aged loblolly (*Pinus taeda* L.)-shortleaf pine (*Pinus echinata* Mill.) and mixed hardwood forest in Central Louisiana were studied along with nutrient-related attributes and seasonal utilization of forage to define the impact of forage dynamics on the habitat capability for white-tailed deer (*Odocoileus virginianus macrourus* Rafinesque). Relationships were studied under three levels of controlled deer stocking.

Herbage and browse yields peaked within two years after logging and progressively declined as overstory competition increased. Browse comprised 75 percent or more of the annual forage production. For three to four years after logging, the habitat appeared capable of supporting one deer on each 12 to 18 acres. Capability declined rapidly thereafter as preferred foods diminished. Within seven years after timber harvest the capability was approaching 40 acres per animal. After 10 years over 40 acres were needed to support one deer yearlong.

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A detailed soils map of the study area was prepared by Alexander Kerr, Jr., Soil Scientist, USDA Soil Conservation Service in cooperation with the Dugdemona Soil Conservation District. Caloric values of forage tissues were determined by Donald R. Dietz, formerly Research Wildlife Biologist, Rocky Mountain Forest and Range Experiment Station, USDA Forest Service, Rapid City, South Dakota. Other nutrient analyses of plant tissues were conducted by E. A. Epps, Jr., Chief Chemist, Feed and Fertilizer Laboratory, Louisiana Agricultural Experiment Station, Baton Rouge. Jerry W. Farrar and Dan Dennett, Jr., Louisiana Wildlife and Fisheries Commission, and the Southeastern Cooperative Wildlife Disease Study Team, University of Georgia, Athens, collected biological and pathological data from deer used in the study.

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Deer Habitat Potential of Pine-Hardwood Forests in Louisiana

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The response of understory vegetation to the management of loblolly (*Pinus taeda* L.)-shortleaf pine (*Pinus echinata* Mill.) forests for timber products largely determines the habitat's ability to support white-tailed deer (*Odocoileus virginianus macrourus* Rafinesque) and many other wildlife species. Periodic logging reduces overstory competition, and forbs and browse that are beneficial to deer temporarily proliferate. Early stages of succession in the understory are, however, short-lived because secondary plant succession progresses rapidly in southern forests (Blair and Brunett 1976). To maintain early stages of succession and a favorable habitat for deer, timber managers must consider the dynamics of understory vegetation.

This study assesses the floral and structural response of the understory and overstory plant community to a selection harvest in an all-aged loblolly-shortleaf pine and mixed hardwood stand in central Louisiana. Forage dynamics are related to the habitat's capacity to support deer. The research began in 1960 immediately after a selection timber harvest and continued through 1970. Understory dynamics were studied under three controlled levels of deer stocking.

Study results are applicable to the 58 million acres of loblolly-shortleaf pine cover type (U.S. Department of Agriculture 1965), particularly natural stands or plantations in the rolling uplands of east Texas, Louisiana, south Arkansas, Mississippi, Alabama, and Georgia.

STUDY AREA

The study was conducted within three 160-acre deer enclosures, each paired with a 20-acre exclosure. Enclosures were maintained at different levels of animal stocking, employing static populations of female white-tailed deer. Facilities were established on the Kisatchie National Forest in Winn Parish, central Louisiana.

The forest was an all-aged, second-growth pine-hardwood stand with a dense multitiered canopy. Loblolly and shortleaf pine were dominant. Prominent hardwoods were southern red oak (*Quercus falcata* Michx.), white oak (*Quercus alba* L.), sweetgum (*Liquidambar styraciflua* L.), American holly (*Ilex opaca* Ait.), blackgum (*Nyssa sylvatica* Marsh.), red maple (*Acer rubrum* L.), and eastern hophornbeam (*Ostrya virginiana* [Mills.] K. Koch).

The understory plant community consisted primarily of tree reproduction, shrubs, and woody vines. Herbaceous flora was sparse. The density of understory vegetation was greatest beneath openings in the tree canopy where the light level was highest.

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Deer, cattle, and domestic hogs ranged the area before the study, but grazing was light. Livestock was excluded from the area during the study.

Before the study, pine and commercially valuable hardwoods were harvested approximately every ten years by the single tree or group selection system. From late 1958 to early 1960 about 18 ft^2 basal area per acre of mature and overmature pine and 10 ft^2 per acre of hardwoods were harvested. White and southern red oaks were the principal hardwood species removed.

The residual stand averaged 84.8 ft^2 basal area per acre in trees ≥ 0.55 inch dbh (table 1). Hardwoods comprised 49 percent of the residual basal area and 84 percent of the stocking per acre. The average pine, however, was nearly two and one-half times larger in diameter than the average hardwood.

Throughout the study at least 77 percent of the hardwoods and 42 percent of the pines were < 3.55 inches dbh. Over 90 percent of the hardwoods and at least 57 percent of the pines were < 6.55 inches dbh. Hardwoods dominated the stocking by a consistent hardwood:pine ratio of about 5.2:1 while pine averaged a little over half of the total basal area. From 1960 to 1970, pine basal area increased 17 percent and hardwood basal area increased 11 percent.

The terrain is essentially rolling hills dissected and well-drained by intermittent drainages. Soils were developed from fine textured Coastal Plain sediments (Pearson and Ensminger 1957). Because of high annual rainfall and excessive leaching, soils are predominantly acid in reaction and low in both organic matter and plant nutrients.

The climate in summer is hot and humid and winters are generally mild. The mean frost-free season is 240 days between March 19 and November 13. Average annual precipitation of 55.4 inches is well distributed throughout the year.

Table 1.—*Stand dynamics of pine and hardwood trees ≥ 0.55 inch dbh following a single-tree selection harvest*

Stand data		1960	1965	1970
Stocking—number/acre	Pine	75	87	89
	Hardwood	386	449	444
	Total	461	536	533
Basal area—ft^2/acre	Pine	43.4	45.0	50.7
	Hardwood	41.4	43.4	46.0
	Total	84.8	88.4	96.7
Mean dbh—in	Pine	10.3	9.8	10.2
	Hardwood	4.4	4.2	4.4

Spring growth of woody perennials begins in late March or early April and twig elongation and tissue maturation are nearly complete on most species by early summer (Kozlowski 1964, Halls and Alcaniz 1965, Blair and Halls 1968). Minor growth activity is common on some species after summer rains, and several broadleaved evergreens, such as Carolina jessamine (*Gelsemium sempervirens* [L.] Ait.), grow during intermittent warm periods in winter. Pines grow throughout most of the frost-free period.

METHODS

Deer Stocking Levels

After an initial inventory of the plant community in late summer 1960, the three 160-acre enclosures were stocked at rates of one deer per 20, 40, and 80 acres (high, medium, and low stocking). No deer were permitted in the exclosures. Enclosures were stocked with animals less than 2 years of age. Before release each doe was x-rayed to exclude pregnant animals, weighed, and equipped with a color-coded collar.

Animal Condition

A young population was maintained in each enclosure by systematically replacing older animals. Each deer removed was weighed and examined for both physical conformation and external parasites. Animals were necropsied for internal parasites, body fat, disease symptoms, and evidence of malnutrition as indicated by bone marrow fat.

Timber Stand

Beginning in winter 1960, timber within each unit (enclosure and exclosure) was sampled at 5-year intervals by the variable-plot-radius method of Bitterlich (Grosenbaugh 1952). The basal area and diameter of all pines and hardwoods ≥ 0.55 inch dbh were determined by species on 24 permanent sampling points established within each enclosure and 18 points within each exclosure. Basal area was sampled with a Relaskop[1]

Understory Plant Community

Forage Production

The net primary production of current leaves and stems of understory vegetation up to 5 feet above ground was determined by the double-sampling technique (Wilm, and others 1944). Production was determined from 96 permanent and 24 temporary milacre quadrats established in a grid pattern within each enclosure and 64 permanent and 16 temporary quadrats within each exclosure (Blair and Brunett 1976). Current growth was sampled by species for woody flora and by five separate classes for herbaceous vegetation: grasses, grasslike plants, composites, legumes, and other forbs.

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[1] Mention of a trade name is solely to identify the equipment and does not imply endorsement by the U.S. Department of Agriculture.

To express forage yield on a dry-weight basis, clipped plant material was dried to constant weight in a forced-draft oven at 65° C. Browse leaves were separated from stems. Leaves of evergreen species, both pines and hardwoods, and twigs from all species were used to estimate the woody forage available after autumnal leaf abscission. Net primary production was sampled in September 1960, 1961, and 1962 and in alternate years thereafter. Yield data excluded spring ephemerals, basal rosettes of leaves produced by some forbs and grasses in winter, and small growth flushes produced by some evergreen shrubs and woody vines during winter warm periods.

Forage Utilization

Systematic observations were made bimonthly to determine the species of herbage and parts of woody plants ingested. Each September before leaf abscission and again in early March immediately before spring green-up, deer utilization of forage plants was determined by visual estimate of the fresh weight of tissue removed by browsing. Utilization was estimated for browse species and for herbage classes on the permanent milacre quadrats within each enclosure. During the early autumn measurement the tips of all browsed twigs were dotted with orange paint to distinguish between summer and winter use.

Forage Nutrient Quality and Dry-Matter Digestibility

In 1964 and 1970, samples of dried current plant growth from clipped quadrats within each unit were used to determine nutrient-related attributes and dry-matter digestibility of summer forages. Plant tissues were grouped into grass and grasslike plants, forbs, browse leaves, and browse twigs for analyses.

Dried tissues were ground through a 2 mm screen in a Wiley mill and analyzed for percentage content of crude protein, phosphorus, and calcium by methods of the Association of Official Agricultural Chemists (1965). Amounts of cell wall constituents (CWC), acid detergent fiber (ADF), acid detergent lignin (ADL), and silica were determined by procedures of Goering and Van Soest (1970). Caloric values, expressed as gross energy, were assayed by oxygen bomb calorimetry (adiabatic calorimeter). Cell solubles were estimated as the difference between the total dry-matter sample and CWC, hemicellulose as the difference between CWC and ADF, and cellulose as the difference between ADF and ADL. Apparent digestible energy (ADE) values were calculated from gross energy determinations using the regression $Y = -0.713 + 0.991X$ (Robbins and others 1975), where $Y = \%$ ADE and $X = \%$ dry matter digestibility.

In vivo dry-matter digestibility was determined for each forage class by the nylon bag procedure (Lowrey 1970) using ruminally cannulated domestic goats as a substitute for deer (Fowle and Church 1973, Short and others 1974). Trials were conducted on 1-gm samples of dry-milled tissue that passed through a 40-mesh screen but were retained by a 60-mesh screen. Nylon-bag dry-matter digestibility values reported herein are averages of the four determinations of each sample (duplicate samples in each of 2 goats).

Cannulated animals were maintained on a balanced commercial ration and native forage until two weeks before digestion trials. They were then placed on native forages only.

Oak Mast

The annual autumn production of acorns was sampled on an area basis using 204 trap points within each enclosure and 150 points within each exclosure, established in a grid pattern. A trap was set only at a sampling point that occurred beneath or within 10 feet of the crown of an oak ≥ 5.55 inches dbh. Grid points not sampled by a trap were regarded as zero yields.

Pine Regeneration

The stocking and distribution of pine seedlings up to 5 feet in height in enclosures and exclosures and browsing on seedlings by deer within enclosures were determined on the permanent milacre quadrats established for measuring understory vegetation. Regeneration was sampled in late summer. Browsing on pines and the degree of injury were recorded in late summer and late winter.

RESULTS

Overstory Dynamics

Selective logging of pines and hardwoods altered the physical structure of the timber stand but had little impact on species composition (Blair and Brunett 1976). Harvest of the large-diameter trees opened the canopy and increased the light, moisture, and nutrients for understory forage plants. Log skidding disturbed the heavy litter accumulation and provided an improved seedbed for plant establishment.

After the reduction in overstory competition, the growth of young trees, particularly hardwoods, increased the density of the multitiered midstory. Light penetration to the understory subsequently declined and forage growth was progressively suppressed or eliminated. Within six growing seasons the stocking of both pines and hardwoods increased 16 percent and stabilized over the next 5 years. Basal area increases were lessened by the loss of several large-diameter pines to bark beetles and the loss of several large oaks and hickories to decay and windthrow.

Pine Regeneration

The number of seedlings ≤ 5 feet in height increased for the first 2 years after logging at all levels of deer stocking but then progressively declined as competition increased from adjacent vegetation (table 2). Most seedlings were ≤ 2 feet in height, which included seedlings of the year. Seedlings tended to survive only beneath canopy openings; therefore, distribution was poor. Mortality was high since young loblolly pine seedlings do not survive long in dense shade after their secondary needles develop, and saplings or larger trees are even less tolerant of shade (Bormann 1956, Wahlenberg 1960).

The number of seedlings > 2 feet in height increased until 1968, followed by a 57 percent decline. Below normal rainfall during summer 1969 seemed to be the principal cause of the excessive mortality. The drought effect was not reflected by the density of seedlings < 2 feet due to the influx of new seedlings during spring 1970.

Forage Production

As expected, growth of forage plants began to decline soon after logging in response to the increasing competition from trees. Responses in the botanical composition and dry-matter yield of herbaceous and browse forage were similar for all deer stocking levels; hence, the results of forage yields reported herein are the average of all stocking regimes.

Herbage

Herbage was sparse within the dense timber stands and growth of forbs and grasses occurred primarily beneath openings in the canopy. The peak yield of dry matter was 100 pounds per acre in 1961, two growing seasons after logging (table 3). Herbage declined rapidly until 1966 when production stabilized at around 23 pounds per acre.

Grasses were the predominant herbage. In 1961 the stands yielded 89 pounds of grass per acre which was 89 percent of the herbage dry matter. Over the next 9 years production of grass declined 84 percent. Forbs declined 86 percent from a peak yield of 14 pounds per acre in 1960 to 2 pounds in 1966.

Uniolas (*Uniola sessiliflora* Poir and *Uniola laxa* [L.] BSP.), which are shade tolerant, contributed over 85 percent of the grass yield. Other common herbaceous species were small panic grasses (*Panicum* spp.), whip razorsedge (*Scleria triglomerata* Michx.), partridgeberry (*Mitchella repens* L.), horseweed (*Conyza canadensis* [L.] Cronquist), trailing lespedeza (*Lespedeza procumbens* Michx.), little tickclover (*Desmodium ciliare* [Muhl.] DC.), hyssop skullcap (*Scutellaria integrifolia* L.), hairy elephantfoot (*Elephantopus to-*

Table 2.—*Stocking of pine regeneration per acre and the percent distribution*[1] *of seedling following a selection harvest*

Height class	1960	1961	1962	1964	1966	1968	1970
0-2.0 ft	5042	6198	3160	2586	1059	712	1156
2.1-5.0 ft	94	137	234	413	606	862	370
Total	5136	6335	3394	2999	1665	1574	1526
Distribution %	61	77	53	56	38	39	41

[1] Based on percent of sample quadrats stocked in late summer with one or more seedlings.

Table 3.—*Net primary production of current forage in pounds dry matter per acre*

Class of vegetation	1960	1961	1962	1964	1966	1968	1970
Herbaceous							
Grass and grasslike plants	72	89	66	33	21	19	14
Forbs	14	11	12	4	2	6	5
Total	86	100	78	37	23	25	19
Browse							
Leaves	201	213	208	163	128	112	81
Twigs	82	79	66	46	34	31	23
Total	283	292	274	209	162	143	104
Browse leaf:twig ratio	2.5:1	2.7:1	3.2:1	3.5:1	3.8:1	3.6:1	3.5:1

mentosus L.), and wrinkled goldenrod (*Solidago rugosa* Ait.).

Browse

Browse, which consists of the current leaves and stems of trees, shrubs, and woody vines, contributed at least 75 percent of the total forage. As with herbage, the net primary production peaked 2 years after logging; the dry-matter yield was 292 pounds per acre (table 3). Yields then declined to a low of 104 pounds in 1970.

Leaves contributed at least 70 percent of the browse yield throughout the study. The leaf:twig ratio increased for about 7 years after logging, indicating an increase in leaf dry matter in response to increased shade. Although overstory competition intensified, the ratio varied little after 1966.

Woody species preferred by deer contributed 44 to 49 percent of the total dry-matter yield of browse (table 4). The peak yield of preferred browse was 140 pounds per acre in 1961, but yields declined 65 percent by 1970. The yield of nonpreferred browse declined 64 percent during this period.

Leaves contributed 64 percent of the dry matter from preferred browse in 1960 and 76 percent by 1970. The leaf:twig ratio of nonpreferred species was larger than that of preferred species due to the preponderance of large-leaved species such as sweetgum, southern red oak, and post oak (*Quercus stellata* Wangenh.) that are nonpalatable to deer.

With leaf abscission from deciduous browse species each autumn the availability of forage from preferred woody species declined greatly (table 5). The percentage loss in preferred browse from leaf fall increased yearly after timber harvest from 58 percent in 1960 to 69 percent in 1970. The growing loss reflected both an increasing leaf:twig ratio of summer growth and a relatively greater decline in the growth of broad-leaved evergreens than of deciduous species.

Table 4.—*Net primary production of preferred and nonpreferred browse in pounds dry matter per acre*

Class of browse	1960	1961	1962	1964	1966	1968	1970
Preferred							
Leaves	89	95	95	68	56	47	37
Twigs	50	45	37	25	20	16	12
Total	139	140	132	93	76	63	49
Leaf:twig ratio	1.8:1	2.1:1	2.6:1	2.7:1	2.8:1	2.9:1	3.1:1
Nonpreferred							
Leaves	112	118	113	95	72	65	44
Twigs	32	34	29	21	14	15	11
Total	144	152	142	116	86	80	55
Leaf:twig ratio	3.5:1	3.5:1	3.9:1	4.5:1	5.1:1	4.3:1	4.0:1
Preferred:nonpreferred browse	1.0:1	0.9:1	0.9:1	0.8:1	0.9:1	0.8:1	0.9:1

Table 5.—*Preferred and nonpreferred browse dry matter available per acre in the late fall and winter seasons and the fraction contributed by leaves*

Class of browse	1960	1961	1962	1964	1966	1968	1970
Preferred—lb	59	56	50	33	25	21	15
Nonpreferred—lb	46	48	45	35	27	27	15
Total—lb	105	104	95	68	52	48	30
Preferred Leaf fraction—%	14.9	20.4	25.7	24.0	21.8	21.4	16.8
Nonpreferred Leaf fraction—%	29.8	28.6	36.0	41.0	46.2	44.0	29.1

Evergreen hardwoods contributed an average of 36 percent of the preferred browse from 1960 to 1970. Their yield declined 76 percent during this period.

Predominant species of preferred browse were the vines Carolina jessamine, common green brier (*Smilax rotundifolia* L.), saw greenbrier (*Smilax bona-nox* L.), and crossvine (*Bignonia capreolata* L.) and the shrubs and tree reproduction American beautyberry (*Callicarpa americana* L.), blackgum, brambles (*Rubus* spp.), red maple, flowering dogwood (*Cornus florida* L.), yaupon (*Ilex vomitoria* Ait.), arrowwood viburnum (*Viburnum dentatum* L.), haws (*Crataegus* spp.), sweetleaf (*Symplocos tinctoria* [L.] L'Her), and Elliott's blueberry (*Vaccinium elliottii* Chapm.). Prevalent species that were either low in preference or nonpreferred were American holly, sweetgum, southern red oak, loblolly and shortleaf pines, muscadine grape (*Vitis rotundifolia* Michx), winter huckleberry (*Vaccinum arboreum* Marsh), witch-hazel (*Hamamelis virginiana* L.), post oak, common deerberry (*Vaccinium stamineum* L.), and rabbit-eye blueberry (*Vaccinium virgatum* Ait.).

Acorn Yields

Lowest production of sound, mature acorns occurred in 1962; highest occurred in 1967. Relatively good crops were also produced in 1961, 1964, and 1968. White and southern red oaks were the primary producers. Yearly production by species of mature, sound acorns was as follows:

Forage Utilization

Although the estimated weight of forage utilized during both summer and winter was directly proportional to animal stocking, it was, at all stocking intensities, far below the amount necessary to maintain the animals. Less than 10 percent of the estimated dry-matter requirement for animal maintenance was accounted for from sample quadrats. This discrepancy could possibly be attributed to insufficient sampling intensity, difficulty in locating evidence of use, and the ingestion of foodstuffs not included in the utilization inventories such as fleshy fruits, acorns, ephemeral forbs and grasses, and mushrooms. Due to the magnitude of the discrepancies, data served only as indices of seasonal use patterns and of differences in species browsed between animal stocking levels.

In evaluating habitat capability, emphasis was given to the degree of browsing on specific indicator species, both preferred and nonpreferred.

Forbs, although relatively sparse, were consistently utilized in spring and summer. Use was particularly prevalent on readily accessible plants growing along roads and fences. Utilization on grasses and grasslike plants, while difficult to distinguish, appeared to be light and sporadic. Use in winter occurred primarily on new growth of panic grasses.

Leaves and twigs of browse were the major forage items ingested. Use of browse leaves appeared

Species of oak	Year									
	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
	pounds dry matter per acre									
White	11.2	1.1	2.1	0.5	4.4	0.0	22.8	7.5	6.9	6.2
Post	0.3	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Southern red	0.5	1.1	3.7	9.5	2.9	3.5	2.4	7.2	1.9	0.6
Water and willow	1.0	0.4	1.4	1.6	1.6	1.9	1.2	3.0	0.5	1.2
Total yield	13.0	2.6	7.2	11.7	8.9	5.4	26.4	17.7	9.3	8.0

to be considerably more prevalent than use of twigs, especially after twig fiber increased with maturity.

A variety of species was browsed during the different seasons. Even nonpreferred or low preference species were often browsed when they were next to a preferred species that was utilized. After autumnal leaf abscission the leaves of broadleaved evergreens such as yaupon, Carolina jessamine, and tardily deciduous dewberries were readily sought by deer.

Seasonal use patterns on browse species were similar between deer stocking levels and constant within an individual enclosure for about five years after logging. As the availability of preferred forage declined with increasing overstory competition, the impact of stocking intensity on the food supply became obvious. At the high level, browsing on nonpreferred pine reproduction increased from 31 seedlings per acre in 1964 to 146 in 1965 and remained high thereafter. The greatest use of pine seedlings occurred in 1969 and 1970 when preferred forage growth was lowest. With few exceptions young pines were browsed in late autumn and winter when green forage was sparse. Under the medium and low stocking levels seedlings were browsed only occasionally. Browsing was never observed on seedlings over 2 feet in height. There was little silvicultural damage as animals ingested only the terminal needles and usually a small portion of the stem. Most browsed seedlings formed a new terminal leader and continued growth.

By 1966, the distribution pattern of browsing at high and medium stocking had changed from scattered spots of concentrated use to area-wide use. Blackgum reproduction and yaupon were being severely hedged under these stocking levels. With high stocking southern waxmyrtle (*Myrica cerifera* L.), a nonpreferred species, received moderate use. In 1967 utilization of leaves and twigs of American beautyberry, a species of moderate to low preference, was increasing appreciably.

The availability of acorns did not noticeably affect the degree of forage utilization in autumn and winter.

Forage Nutrient Quality and Digestibility

Forage nutrient quality is at its peak during rapid spring growth when tissues are succulent (Blair and others, in press, Blair and Epps 1969, Blair and Halls 1968, Causey 1964). By early summer growth is nearly complete; nutrient levels decline rapidly and fiber levels elevate. Browse leaves were the most nutritious forage available in summer; grasses and current browse twigs were poorest in quality (table 6). With tissue mat-

Table 6.—*Mean summer nutrient composition and dry-matter digestibility of forages.*

Forage class and year	Composition as Percent Oven-Dry Weight												
	Crude protein	Phosphorus	Calcium	Cell solubles	Cell wall content	Acid detergent fiber	Hemicellulose	Acid detergent lignin	Cellulose	Silica	Gross energy cal/g	Dry-matter digestibility percent	Apparent digestible energy cal/gm
Grass and grasslike plants													
1964	7.5	0.064	0.33	25.5	74.5	46.7	27.8	10.0	36.7	8.00	3964	31.6	1213
1970	6.2	0.060	0.22	21.4	78.6	47.2	31.4	10.7	36.5	5.47	4130	28.9	[illegible]
Forbs													
1964	8.3	0.072	1.08	44.2	55.8	43.9	11.9	13.8	30.1	2.84	3975	47.4	1839
1970	8.0	0.077	1.16	44.5	55.5	47.3	8.2	13.1	34.2	2.80	4047	49.0	[illegible]
Browse leaves													
1964	10.9	0.083	1.04	62.8	37.2	30.2	7.0	12.7	17.5	0.76	4365	71.7	[illegible]
1970	10.1	0.086	1.09	63.6	36.4	30.7	5.7	12.7	18.0	0.65	4400	68.5	2956
Browse twigs													
1964	4.8	0.052	0.67	28.6	71.4	56.1	15.3	18.3	37.8	0.31	4262	26.6	[illegible]
1970	4.4	0.054	0.55	25.7	74.3	58.1	16.2	19.4	38.7	0.14	4344	27.2	[illegible]

uration fiber increases considerably less in browse leaves than in twigs and herbage (Blair and others, in press, Short, and others 1975).

In 1964 and 1970 over 71 percent of the summer dry matter of grasses and woody twigs and 55 percent of the forb dry matter consisted of poorly- or non-digestible cell wall constituents. In contrast, 63 percent of the leaf tissue in summer consisted of highly digestible cell solubles which include lipids, sugars, organic acids, nonprotein nitrogen, pectins, soluble protein, and other water soluble matter.

The crude protein level of leaves was higher than for other forages in summer and was above the estimated daily maintenance requirement for deer of 7 percent of the dry matter (Magruder and others 1957). Phosphorus levels in all forages, however, were well below the estimated minimum daily maintenance requirement of 0.25 to 0.30 percent. Nondigestible acid detergent lignin, which includes aliphatic cutin and silica, was comparatively high in leaves. Cutin is believed to be extremely resistant to microbial degradation; hence, along with silica and lignin, it adversely affects nutritive value (Van Soest 1970).

In summer 1961 forage yielded approximately 34.6 pounds of crude protein per acre (table 7). By 1970 forage production had declined 64 percent and the protein yield was 10.5 pounds. Phosphorus declined from about 0.283 to only 0.094 pounds per acre during this period and cell solubles declined 66 percent from 184.0 to 62.6 pounds per acre. In 1961 leaves contained about 67 percent of the crude protein, 63 percent of the phosphorus, 70 percent of the calcium, 73 percent of the cell solubles, and 75 percent of the estimated apparent digestible energy in summer forages. By 1970 leaves in summer contained about 78 percent of the crude protein, 74 percent of the phosphorus, 80 percent of the calcium, and 82 percent of the cell solubles and estimated apparent digestible energy.

Leaf tissues were the most digestible summer forage while the highly fibrous grasses, grasslike plants, and browse twigs were the least digestible (table 6). Dry-matter digestibility of forages varied little between 1964 and 1970.

Table 7.—*Approximate summer nutrient yields per acre by forage classes at 3, 5, and 11 years after a selection timber harvest*

Forage class and year	Crude Protein	Phosphorus	Calcium	Cell Solubles	Cell Wall Content	Digestible Dry matter	Gross Energy	Apparent Digestible Energy
	pounds						*MKcal*	
Grass and grasslike plants								
1961[1]	6.7	0.057	0.29	22.7	66.3	28.1	160.03	49.00
1964	2.5	0.021	0.11	8.4	24.6	10.4	59.34	18.16
1970	0.9	0.008	0.03	3.0	11.0	4.0	26.23	7.33
Forbs								
1961[1]	0.9	0.008	0.12	4.9	6.1	5.2	19.83	9.17
1964	0.3	0.004	0.04	1.8	2.2	1.9	7.21	3.33
1970	0.4	0.004	0.06	2.2	2.8	2.4	9.18	4.39
Browse leaves								
1961[1]	23.2	0.177	2.22	133.8	79.2	152.7	421.73	296.65
1964	17.8	0.135	1.70	102.4	60.6	116.9	322.73	227.01
1970	8.2	0.070	0.88	51.5	29.5	55.5	161.66	108.59
Browse twigs								
1961[1]	3.8	0.041	0.53	22.6	56.4	21.0	152.73	39.17
1964	2.2	0.024	0.31	13.2	32.8	12.2	88.93	22.81
1970	1.0	0.012	0.13	5.9	17.1	6.3	45.32	11.89
TOTAL								
1961	34.6	0.283	3.16	184.0	208.0	206.9	754.32	393.99
1964	22.8	0.184	2.16	125.8	120.2	141.9	478.21	271.31
1970	10.5	0.094	1.10	62.6	60.4	68.2	242.39	132.20

[1] Estimates based on 1961 forage yields in conjunction with nutrient composition of forages derived in 1964.

Animal Condition

Malnutrition was never evident in study animals removed from enclosures from 1961 to 1971. Further, incidence of internal parasites was not related to the population density of deer. Live weights of animals removed from enclosures between 1966 and 1971, a period when browse use indicated excessive and increasing pressure on the food supply at both heavy and medium stocking levels, were not noticeably related to population density. Young deer at stocking time averaged 50.6 pounds and 7.6 months of age. At the time of removal, after at least 18 months confinement, weights in March and April averaged 87.7 pounds under heavy stocking, with individual weights ranging from 70 to 105 pounds. With medium stocking, spring weights averaged 81.6 pounds, ranging from 67 to 107 pounds and with light stocking the average was 93.2 pounds, ranging from 86 to 100 pounds.

DISCUSSION

The capability of all-aged loblolly-shortleaf pine-hardwood stands to sustain deer largely depends upon the intensity and frequency of timber cutting. With timber harvest and a reduction in competition, the forage-nutrient base peaks and then declines as overstory competition increases. To sustain an adequate nutrient base for the growth and maintenance of deer, timber stands must be thinned frequently and sufficiently to stimulate a diversified growth of palatable and nutritious forage.

The capability can be estimated by relating the seasonal metabolic needs of animals to the nutrients available in the food supply. The pattern of seasonal use on available forage species provides supporting evidence. The precision of capability estimates can be enhanced by specifically relating the seasonal metabolic needs of deer to animal sex, age, and physiologic activity. Cover and water are seldom deficient in the habitat.

For 3 or 4 years after harvest the habitat in this study appeared capable of sustaining one deer on about 12 to 18 acres during the warm season. With a stocking of one deer per 20 acres palatable species of browse were only lightly used, suggesting an even greater capability. Habitat capability estimated from an evaulation of the forage-nutrient supply and approximate metabolic needs of deer supported the capability indicated by the pattern of forage utilization. For example, in 1961, the peak year of forage production, roughly 34.6 pounds of crude protein per acre were yielded in summer by forage dry matter (table 7). Considering only the protein available in forbs and half the leaves of palatable browse species (50 percent proper use assumed for browse leaves) and assuming a 75-pound deer might require between 0.35 and 0.43 pound of protein per day for proper growth performance (Magruder and others 1957), 14 to 17 acres would be needed to supply protein for one animal during the 240 day warm season. While forbs and browse leaves are principal forages for deer (Harlow and others 1975), added protein would undoubtedly be obtained from mushrooms and tender twig tips, thereby improving the estimate of capability.

Habitat capability indicated in 1961 by the relationship of energy supply to metabolic need was 10 acres per deer during the warm season, somewhat higher than that suggested by a protein evaluation. The daily gross energy requirement for growth of a 75 pound deer was assumed to be 4725 Kcal (Magruder and others 1957).

Phosphorus appeared to be a limiting factor in the nutrient supply. Low forage phosphorus, however, can be expected in these habitats since soil phosphates available for root absorption are readily leached by the high annual rainfall (Lytle 1960). During feeding, deer possibly selected forage tissues that were relatively high in phosphorus and supplemented this by consuming mushrooms which are a good source of phosphorus. Swift (1948) and Longhurst and others (1968) concluded that deer can apparently select plants and plant fractions higher in nutrients than those sampled by man.

From 1961 to 1964 the summer supply of crude protein in the dry matter of forbs and the leaves of palatable browse declined about 32 percent as competition intensified within the plant community. By 1970 it declined an additional 32 percent to only 4.1 pounds per acre. The gross energy potential in these summer forage fractions declined approximately 32 percent between 1961 and 1964, from an estimated 207,930 Kcal per acre to 141,850 Kcal. The energy potential was down an additional 28 percent by 1970, to a supply of 83,030 Kcal per acre.

Utilization of palatable browse as well as use of nonpreferred pine seedlings was increasing by 1964 at the high stocking level. By 1966, seven years after logging, deer at this stocking density were commonly browsing several nonpreferred species, such as southern waxmyrtle, sweetgum, American beech (*Fagus grandifolia* Ehrh.), and tree sparkleberry. Winter use on loblolly and shortleaf pine seedlings had increased substantially. Several species, such as blackgum and yaupon were now being hedged under both the high and medium levels. The pattern of browse use indicated excessive pressure on the food supply and a progressively declining habitat capability.

Forage use data indicated a capability in 1964 of a little over 20 acres per deer, approaching 40 acres by 1966 and exceeding 40 acres by 1970.

The declining capability was substantiated by relating nutrient supply to metabolic needs of deer. In 1964 the relationship between crude protein supplied by forbs and half the leaves of palatable browse and estimated requirements for growth of a 75-pound animal indicated that 21 to 26 acres might be needed for one deer during the frost-free period. The gross energy potential indicated a need of about 15 acres per animal. The capability indicated by crude protein appeared more realistic when compared to the pattern of forage use than did the somewhat higher potential suggested by gross energy. By 1970, habitat capability estimated on the basis of protein relationships had diminished to a range of 38 to 47 acres per deer. Based on gross energy, the estimated capability was 25 acres per animal. Again, the estimates founded on protein relationships appeared to be better correlated with forage use than that based on the supply and animal needs of gross energy.

Habitat capability declines with the autumnal loss of nutrients contained in forbs and deciduous browse leaves. From 1960 to 1970 leaf dry matter of palatable browse declined an average of 89 percent with autumnal abscission although nutrient quality changed little from summer to winter (Blair and Epps 1969, Blair and others, in press). Both the leaves of broadleaved evergreens and twig tips were utilized by deer during the winter. Soft fruits (Hastings 1966), acorns, the green basal rosettes of forbs, and mushrooms undoubtedly contributed additional nutrients during the cold season stress period.

A productive habitat, capable of supporting one deer on less than 40 acres, can be sustained in pine-hardwood stands by shortening the cutting cycle on management units from the common practice of 10 or more years to a maximum of 7. A preferable system for maintaining a quality forage base can be achieved by dividing a management compartment into 40- to 50-acre units and cutting alternate units, in a checkerboard pattern, every five years. The latter system would provide a more favorable habitat diversity and a consistently higher nutrient base than less frequent logging over a larger area.

Timber harvest must be sufficiently heavy to provide a substantial increase in light energy reaching vegetation in the deer feeding zone. Therefore a higher habitat capability can be maintained by increasing the cutting intensity and/or frequency. Where cutting is delayed and the deer population exceeds the food base, damage not only to food plants but also to forest regeneration becomes increasingly substantial. The supply of forage nutrients can be increased by felling palatable hardwoods and shrubs that have grown beyond the deer feeding zone to stimulate resprouting (Blair and Feduccia, in press). Woody species that are nonpreferred as forage and have no food value as fruit producers or commercial value for wood products should be eliminated to reduce the competition to desirable forage.

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For three to four years after logging, an all-aged pine-hardwood forest in Central Louisiana appeared capable of supporting one deer on each 12 to 18 acres. Capability declined rapidly thereafter as overstory competition increased and preferred foods diminished. Within seven years after timber harvest the capability was approaching 40 acres per animal and after 10 years over 40 acres were needed to support one deer yearlong.

Additional keywords: White-tailed deer, loblolly-shortleaf pine, secondary succession, forage yield, forage quality, nutrients, deer enclosures.

Metric Conversions

Basal Area	m^2 per hectare = 0.2296 (ft^2 per acre)
DBH	cm = 2.54 (in)
Height Class	m = 0.3048 (ft)
Nutrient Yields	MKcal per hectare = 2.471 (MKcal per acre)
Plot Size, Quadrats	0.0004 hectare = 1 milacre
Production	Kg per hectare = 1.1208 (lb per acre)
Stocking	number per hectare = 2.471 (number per acre)

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Ten-Year Growth Following Thinning of Slash Pine Planted on Medium To Poor Cutover Sites

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DONALD P. FEDUCCIA

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SUMMARY

During two 5-year growth periods following thinning of planted slash pine on medium to poor cutover sites, periodic annual cubic-foot volume and basal area growth were directly related to residual basal area per acre and site index, and inversely related to age. Diameter increment of all trees and the dominant segment of the stand decreased with higher densities, and increased directly with site index. Age had no appreciable effect.

1977

Ten-Year Growth Following Thinning of Slash Pine Planted on Medium To Poor Cutover Sites

DONALD P. FEDUCCIA

Slash pine (*Pinus elliottii* Engelm. var. *elliottii*) has been planted on a broad array of sites north and west of its natural range. Growth data for thinned slash plantations on cutover sites in the West Gulf Region are needed by forest landowners to facilitate management decisions.

THE STUDY

The study was installed in 14- and 16-year-old slash pine plantations in west central Louisiana, on land formerly occupied by longleaf pine (*P. palustris* Mill.). The stands had been established by machine planting using 1-0 nursery stock at a spacing of approximately 6 by 8 feet (908 seedlings per acre). At the time the study was installed the younger plantation had 670 trees per acre averaging 4.7 inches in diameter, and 967 cubic feet (ob) per acre of merchantable volume (trees of merchantable volume are 4 inches in diameter and larger up to a 4 inch top, dob). The older stand averaged 706 trees per acre, with 1,349 cubic feet (ob) per acre of merchantable volume, and trees had a mean diameter of 4.9 inches. Fusiform rust (*Cronartium fusiforme* Hedgc. and Hunt ex Cumm.) stem infection was relatively low in both plantations, averaging 9.8 percent in the younger stand and 7.8 percent in the older.

Soil is of the Mayhew series. Topography is flat to gently rolling, with no slopes exceeding 5 percent.

Site indices, ranging from 60 to 87 feet (age 50), were determined from heights of dominant and codominant trees on each of 40 plots, using slash pine site index curves from USDA Miscellaneous Publication 50 (1929).

Residual densities of 40, 55, 70, 85, 100, 115, and 130 square feet of basal area per acre were selected as thinning levels. An unthinned check was also included. Two replications of each treatment were assigned to the younger plantation and three replications allotted to the older stand. Thinnings were scheduled at 5-year intervals.

Measurement plots were 0.15 acre in size and surrounded by an isolation strip 0.5 chain wide. On thinned plots, the isolation strip was cut to the same basal area level as the measurement plot.

All plots assigned densities of 40, 55, and 70 square feet per acre were thinned at the time the study was installed. On plots in the 14-year-old stand assigned densities of 85 or more square feet per acre, basal areas (BA) were too low to necessitate cutting. In the 16-year-old plantation, one of the three BA-85 plots, two of the BA-100 plots, and those assigned higher residual basal area levels did not require thinning. Five years later, all plots except four of the BA-130 treatment had reached the assigned stocking levels.

The first thinning removed mostly diseased and defective trees on lightly thinned plots. On plots assigned low residual basal area levels that had

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high initial stocking, some trees in all crown classes were removed to allow residual stems more space. For the second thinning, diseased and defective trees were again given top priority. As the intensity of thinning was increased, cutting larger trees was more common.

Unthinned checks averaged 76 square feet of basal area per acre for the 14-year-old stand and 101 square feet for the 16-year-old plantation. Five years later, density averaged 111 square feet per acre in the older plantation.

Measurements were taken at the time of the installation of the study and at 5-year intervals on the central 0.15 acre of each plot. Diameters to the nearest 0.1 inch were tallied on all trees with a dbh of 0.6 inch and larger. The number of trees sampled for volume was allotted to each diameter class in proportion to the diameter distribution on each plot. Total height and height to succeeding 2-inch taper steps were obtained on the volume sample trees. Height accumulation was used to calculate volume for each sample tree (Lohrey and Dell 1969). Plot volumes were then computed by multiplying total basal area by the volume/basal area ratios for sample trees on the plot.

Regression analyses used the REX-FORTRAN-4 system for combinatorial screening (Grosenbaugh 1967). Various functions of site (S), residual basal area (BA), age (A), and interactions of these variables were examined for their effect on gross periodic annual cubic volume, basal area, and diameter increment. Growth data from all plots, both thinned and unthinned, were combined for the analyses. Therefore, predicted values for basal area levels above 85 square feet per acre during the first growth period and above 115 square feet of basal area per acre for the second growth period represent the unthinned condition. Gross growth was used since mortality was light, ranging from 0 to 77 cubic feet (ob) per acre on individual plots over the 10-year study period.

Diameter distribution by stocking densities from the 24- and 26-year-old plantations were combined to obtain average values at age 25. The BA-130 treatment was not included since only one replication from the older plantation received a thinning. The data from the BA-115 treatment were the average of two replications, one from each of the plantations. Data from plots not thinned that were assigned to these two treatments were combined with that from unthinned plots. Distributions for the unthinned check were an average of five replications from the younger plantation and seven from the older. Average basal area for the 12 unthinned plots was 116 square feet per acre at the beginning of the second 5-year growth period.

Total yields were determined at age 15 by averaging actual volumes in the two plantations by site index classes. The volumes were 834, 1,103, and 1,330 cubic feet (ob) per acre for sites 65, 75, and 85 feet, respectively. Ten-year periodic growth, taken from table 1, was added to the volume at age 15 to obtain 25-year production.

Computing Volume Growth

Gross periodic annual cubic foot volume growth (ob) for the periods 15 to 20 and 20 to 25 years was specified for trees 4 inches and larger dbh up to a 4-inch top, dob. This growth was estimated for the two 5-year intervals beginning at age 15 and 20. In the regression equation, site index (S), age (A), and common logarithm of basal area ($\log_{10}$ BA) were used as independent variables. The selected prediction is:

$$\mathrm{PAI_V} = -580.13137 + 1.3171593\,(S) + \frac{5036.2108}{A} + 93.739564(\log_{10} BA) + 1.7560652(S \times \log_{10} BA)$$

where:

$\mathrm{PAI_V}$ = Periodic annual volume growth per acre (cubic feet)

A = Stand age at the beginning of the growth period

BA = Residual basal area at the beginning of the growth period (square feet per acre)

S = Site index, base age 50

$R^2 = 0.79$

$S_{y \cdot x} = 33.31$

The equation is significant at the 0.01 level.

Computing Diameter Growth

Site, age, and residual basal area were the independent variables selected to predict average periodic annual diameter growth from 15 to 20 and from 20 to 25 years for all trees and for the 60 largest trees per acre. The equations are:

$$PAI_D = 0.55246863 + 0.0049077627(S) - \frac{0.5065532}{A} - 0.3817444(\log_{10} BA)$$

PAI_D = Periodic annual diameter growth for all trees

R^2 0.90

$S_{y \cdot x} = 0.02$

$$PAI_{D\,60} = 0.31302299 + 0.0052189638(S) + \frac{0.66918495}{A} - 0.25501287(\log_{10} BA)$$

$PAI_{D\,60}$ = Periodic annual diameter growth for 60 largest trees per acre

$R^2 = 0.84$

$S_{y \cdot x} = 0.02$

Both equations are significant at the 0.01 level.

Computing Basal Area Growth

The same independent variables selected for diameter growth were used to predict average gross periodic annual basal area growth for all trees from 15 to 20 and from 20 to 25 years. The equation is:

$$PAI_{BA} = -11.766522 + 0.077690884(S) + \frac{82.643395}{A} + 3.5424794(\log_{10} BA)$$

PAI_{BA} = Periodic annual basal area growth (square feet per acre)

$R^2 = 0.77$

$S_{y \cdot x} = 0.59$

The equation is significant at the 0.01 level.

RESULTS

Volume Growth

Volume growth was directly related to basal area per acre. Maximum volumes were obtained with the highest residual basal areas across all sites (Table 1). Differences for each 10-foot increase ranged from 23 cubic feet per acre at low density levels to 7 cubic feet at high levels.

Site had a strong influence on volume increment, equivalent to 41 to 50 cubic feet per acre yearly of additional growth for each 10-foot increase in site index.

Periodic annual volume growth was excellent for the various sites and stocking levels during the first 5-year period. It exceeded 170 cubic feet per acre annually on plots with low residual density on sites with indices of 65 and was over 350 cubic feet annually on unthinned plots on sites with indices of 85.

Ingrowth during the first 5-year period averaged 11 cubic feet per acre per year for the thinned plots and 17 cubic feet per acre annually for the unthinned stands.

PAI_V for all stocking levels and site classes from 20 to 25 years was 84 cubic feet per acre less than that from 15 to 20 years. This decrease was mainly due to a slowing of height growth and a decrease in basal area increment. Ingrowth during this period was negligible.

During the first growth period, stands thinned to 80 square feet per acre at age 15 showed about 1.3 times more volume growth than those thinned to 40 square feet per acre. Stands thinned to a residual density of 100 square feet per acre at age 20 grew about 1.4 times more in volume than those thinned to 50 square feet per acre.

Diameter Growth

Diameter growth was inversely related to density, and increased directly with site index (Tables 2 and 3). A 10-foot elevation in site resulted in a 10-year average incremental gain of 0.5 inch in diameter. Increasing stand density by 10 square feet per acre reduced diameter growth an average of 0.31 inch in 10 years for all trees between residual levels of 40 to 70. Densities of 70 to 100 square feet per acre showed a reduction in growth of 0.20 inch over the same period and decreased 0.10 inch on plots of more than 100 square feet per acre.

For the 60 largest trees per acre, the effect of higher residual stocking on average diameter growth was less than for all trees. For stocking levels between 40 and 80 square feet per acre, the diameter increment declined an average of 0.20 inch over 10 years with each 10-foot increase in density. Above 80 square feet per acre, the diameter increment was reduced 0.10 inch over 10 years.

Diameter growth of all trees during the second 5 years increased 0.01 inch per year over the increment obtained in the first 5 years. The opposite occurred with the 60 largest trees per acre. If the number of all trees per acre had remained constant, average dbh growth per tree would also

Table 1.—*Estimated gross periodic annual volume increment (ob) per acre of merchantable trees from 15 to 20 and from 20 to 25 years.*

Site index (feet)	5-year growth period	Residual basal area per acre (sq ft)													
		40	50	60	70	80	90	100	110	120	130	140	150	160	170
		Cubic feet[1]													
65	15-20	174	194	211	225	237									
	20-25	90	110	127	141	153	164								
75	15-20	216	237	255	270	283	295	305	315						
	20-25	132	153	171	186	200	211	221	231	239					
85	15-20	257	280	300	316	330	342	354	364	373	381	389			
	20-25	173	196	216	232	246	258	270	280	289	297	305	312	319	326

[1] Divide by 90 cubic feet for approximate conversion to standard cords.

Table 2.—*Estimated periodic annual diameter growth of all trees from 15 to 20 and from 20 to 25 years.*

Site index (feet)	5-year growth period	Residual basal area per acre (sq ft)													
		40	50	60	70	80	90	100	110	120	130	140	150	160	170
		Inch													
65	15-20	0.23	0.19	0.16	0.13	0.11									
	20-25	.23	.20	.17	.14	.12	0.10								
75	15-20	.28	.24	.21	.18	.16	.14	0.12	0.11						
	20-25	.28	.25	.22	.19	.17	.15	.13	.12	0.10					
85	15-20	.32	.29	.26	.23	.21	.19	.17	.16	.14	0.13	0.12			
	20-25	.33	.30	.26	.24	.22	.20	.18	.16	.15	.14	.13	0.11	0.10	0.09

Table 3.—*Estimated periodic annual diameter growth of the 60 largest trees per acre from 15 to 20 and from 20 to 25 years.*

Site index (feet)	5-year growth period	Residual basal area per acre (sq ft)													
		40	50	60	70	80	90	100	110	120	130	140	150	160	170
		Inch													
65	15-20	0.29	0.26	0.24	0.23	0.21									
	20-25	.28	.25	.23	.22	.20	0.19								
75	15-20	.34	.32	.30	.28	.26	.25	0.24	0.23						
	20-25	.33	.30	.28	.27	.25	.24	.23	.22	0.21					
85	15-20	.39	.37	.35	.33	.32	.30	.29	.28	.27	0.26	0.25			
	20-25	.38	.36	.34	.32	.30	.29	.28	.27	.26	.25	.24	0.24	0.23	0.22

have decreased. However, there were fewer trees per acre during the second 5 years because of thinning and mortality in the lower crown classes. Including age as an independent variable did not appreciably increase the variation explained by the regression equation, but was done so that all data could be presented in a consistent manner.

Basal Area Growth

Periodic annual basal area growth increased directly with site and residual density, and decreased with age (Table 4). Over the 10-year period, plots on sites with indices of 85 grew slightly over 15 square feet per acre more than plots on sites with indices of 65.

The annual increase in basal area growth ranged from 0.09 to 0.35 square feet with each 10-foot rise in stocking level. The greatest increase occurred at low density levels. Growth declined about 1.4 square feet yearly during the second growth period, as compared to the first.

Diameter Distributions

At age 25, the heaviest thinning (BA-40) had more trees 9 inches dbh and larger than any other treatment (Table 5). Light cutting (BA-100 and BA-115) excelled in trees 8 inches and more in diameter. For the two light thinnings and the unthinned plots, differences in trees 7 inches and larger were small. Unthinned plots exceeded all thinning treatments beginning with the 5-inch and larger class.

Total Yield

Total volume yields at age 25 were 2.6 to 3.5 times greater than yields at age 15 (see Total yields, p. 2 and Table 6). Site quality strongly influenced total yield. Plots on sites with an index of 85 produced 51 to 62 percent greater volume than those with an index of 65. Thinning reduced total yield below that of the unthinned check.

Table 4.—*Estimated gross periodic annual basal area growth per acre of all trees from 15 to 20 and from 20 to 25 years.*

Site index (feet)	5-year growth period	Residual basal area per acre (sq ft)													
		40	50	60	70	80	90	100	110	120	130	140	150	160	170
		Square Feet													
65	15-20	4.47	4.81	5.09	5.33	5.53									
	20-25	3.09	3.43	3.71	3.95	4.16	4.34								
75	15-20	5.24	5.59	5.87	6.11	6.31	6.49	6.65	6.80						
	20-25	3.87	4.21	4.49	4.75	4.93	5.12	5.28	5.42	5.56					
85	15-20	6.02	6.37	6.65	6.88	7.09	7.27	7.43	7.58	7.71	7.84	7.95			
	20-25	4.64	4.99	5.27	5.51	5.71	5.89	6.05	6.20	6.33	6.46	6.57	6.68	6.78	6.87

Table 5.—*Diameter distribution of trees per acre at age 25.*

Residual basal area per acre (sq.ft.)	index (feet)	Dbh (inches)												
		1	2	3	4	5	6	7	8	9	10	11	12	Total
		Number												
40	75		1	11	5	13	13	21	24	51	29	4		172
55	77			11	13	13	28	43	64	44	17	9	1	243
70	76		1	36	25	47	64	69	63	43	20	3	1	372
85	78	1	9	28	29	51	64	89	79	44	21	7		422
100	80	1	4	39	67	49	87	94	98	49	19	4		511
115	81			37	67	67	130	117	93	53	20	3		587
Unthinned	77		22	49	63	96	119	133	82	39	18	3		624

Table 6.—*Estimated total production per acre at age 25 of trees 4-inches and larger to 4-inch top, dob*

Residual basal area per acre Sq. ft.)	Site index		
	65	75	85
	(Cubic feet (ob)		
40	2,154	2,843	3,480
60	2,524	3,233	3,910
80	2,784	3,513	4,210
Unthinned[2]	—	3,823	4,545

[1] Divide by 90 cubic feet for approximate conversion to standard cords.

[2] Average residual density of 100 square feet per acre at age 15 and 120 square feet per acre at age 20.

DISCUSSION

The relationships of growth to stocking presented in this paper are similar to trends from other studies in slash plantations, which have shown that thinning to low residual basal areas increased diameter increment at the sacrifice of cubic volume growth (Enghardt and Mann 1972, Mann and Enghardt 1972, and Feduccia 1974). The primary importance of this paper is the estimated values recorded for periodic annual growth for various residual density levels from slash plantations on poor to medium cutover sites, outside the natural range of this species. Most previously published data for the West Gulf Region have been for site indices of 85 feet (age 50) or higher.

Within the range of stocking levels, site classes, and ages reported, stagnation of growth did not occur. A slowing of height growth during the second 5-year period was not related to stand density. Height growth rate decreased at about the same magnitude for both thinned and unthinned plots. Diameter growth was slower at high densities than at low, but the decline was gradual with no sudden drop at any basal area level.

Thinning is likely to play a minor role in the development of slash pine plantations in the West Gulf where rotations of 35 years or less are selected; however, diameter increment can be maintained with thinning. For short rotations, unthinned slash plantations will produce the maximum cubic volume yields. Under these conditions, thinning should not be viewed as a product developer. Thinning had little effect on the number of trees in the larger diameter classes (Table 5). Only impractical thinning to BA-40 resulted in a greater number of these larger trees than no thinning. To achieve this advantage from a very heavy thinning, many small trees had to be removed at ages 14 and 16 years.

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For slash pine planted on medium to poor cutover sites and selectively thinned, periodic annual cubic-foot volume and basal area growth were directly related to residual basal area per acre and site index and inversely related to age during two 5-year growth periods. Higher densities caused a decrease in diameter for dominant trees and all trees.

Additional keywords: *Pinus elliottii,* thinning, diameter distribution.

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CONVERSION TO METRIC UNITS

Cubic meters per hectare = Cubic feet per acre ÷ 14.2913
Square feet per hectare = Square feet per acre ÷ 4.356
Number per hectare = Number per acre × 2.471
Centimeters = Inches × 2.54
Meters = Feet × 0.3048

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Chemical and Physical Properties of Cumberland Plateau and Highland Rim Forest Soils

JOHN K. FRANCIS
AND
NELSON S. LOFTUS

Southern
Forest
Experiment
Station

Summary

Soil descriptions and chemical and physical data for a number of soils of the Cumberland Plateau, eastern Highland Rim, and western Highland Rim areas of Tennessee are presented.

1977

Chemical and Physical Properties of Cumberland Plateau And Highland Rim Forest Soils

JOHN K. FRANCIS AND NELSON S. LOFTUS

Introduction

The Sewanee Silviculture Laboratory is conducting extensive trials to determine how well certain tree species will grow on several Cumberland Plateau and Highland Rim forest sites. A corollary objective is to determine what soil factors limit or promote tree growth on these sites. As a part of this research, soil morphology and site characteristics were recorded at each site and samples were taken from each soil horizon for physical and chemical analysis. A typical profile description and average chemical and physical data are presented in this paper.

Little soil analysis data has been available for the Cumberland Plateau-Highland Rim area. Until now, the most significant soils data pertinent to the area were *Soil Survey Laboratory Data and Descriptions for Some Soils of Tennessee* (USDA 1967), which contains profile descriptions and physical and chemical data for some of the soils of the Plateau-Rim area. The soil surveys, though many are rather old, are another important source, containing soil descriptions and some physical data, as well as being the standard source of soil maps. Other useful sources of related soil data are Peters and others (1970), Longwell and others (1963), and Edwards and others (1974).

Our data, though the most comprehensive now available, have certain limitations. Because the soil pits were located in plots established for site evaluation, the soil series encountered was usually by chance. As a result not all important forested soil series in the area were represented, and the number of observations per soil series varies. Also, the observations are not evenly distributed among the physiographic provinces. In this paper, soil series of the eastern Rim are separated from those of the western Rim when in reality considerable overlap occurs. Certain profiles should have been classified into families in which no suitable series has been established. Therefore, they were placed in an established series which they resembled closely.

Geography of Study Area

The Cumberland Plateau, extending from central Kentucky to central Alabama (fig. 1), owes its origin to protection from erosion by a massive sandstone caprock that has maintained the present elevation while surrounding areas have been eroded by dissolution of underlying limestone and sapping of the sandstone cap. This has resulted in a gently rolling topography with gentle bottoms grading to deeply cut streams (fig. 2). Abrupt escarpments mark the edges of the plateau. Parent materials include sandstone, siltstone, and shale. Soils are mostly highly leached Ultisols in siliceous mesic families. Nitrogen, phosphorus, and calcium content is usually less than adequate for best tree growth.

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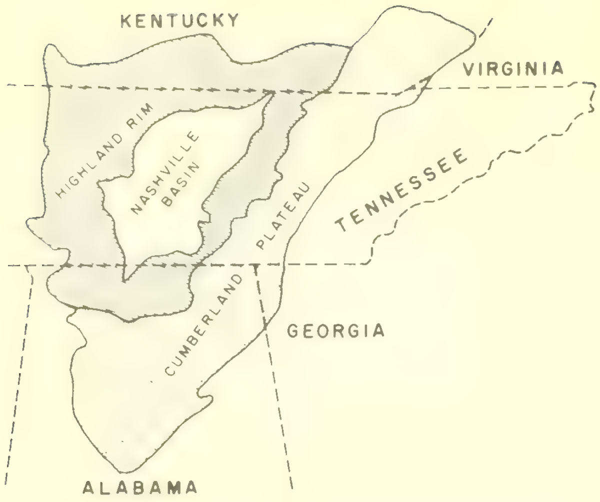

Figure 1.—*Location of the Cumberland Plateau and Highland Rim physiographic provinces.*

The Cumberland Plateau has warm summers and cool winters and receives about 54 inches of rainfall. This climate fosters a mixed mesophytic forest dominated by oak species. Most of the Plateau area in Tennessee remains forested. The majority of the timber holdings are cut over periodically, with only a few areas judiciously managed for sustained yield of forest products.

The Highland Rim is a broad peneplane that rings the somewhat lower Nashville Basin. The present level of the Highland Rim resulted from erosion of the overlying limestone and sandstone. Most of the area has a highly siliceous limestone or chert residuum underlying the soil mantle. Soils are mostly highly leached Ultisols of the siliceous thermic families. Summers are warm, winters mild, and annual rainfall is about 52 inches per year. The Highland Rim is divided into two physiographic subdivisions: the eastern Highland Rim and the western Highland Rim.

The eastern Rim has a gently undulating topography (fig. 3) with mostly loamy soils and some silty areas. Part of the area is occupied by fairly productive soils of a reddish hue, and part, including the area from which our samples came, is covered by silty, light-colored, relatively infertile soils, usually with fragipans in their subsoils. The forest of the eastern Rim is western mesophytic dominated by oak species. Most of the eastern Rim has been cleared for annual cropping or pasture, and forest holdings are usually woodlot in size with little modern timber management.

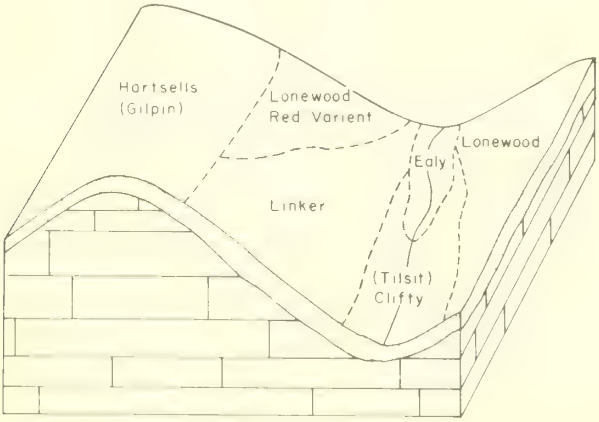

Figure 2.—*Soil series-landscape relationships of the Cumberland Plateau. (Soils in parenthesis occur over siltstone rather than sandstone parent material.)*

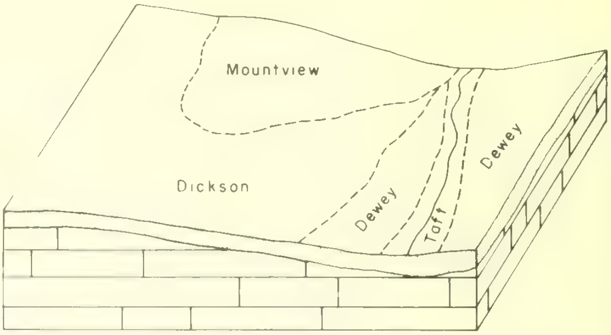

Figure 3.—*Soil series-landscape relationships of the eastern Highland Rim.*

The western Rim is somewhat more dissected than the eastern Rim (fig. 4). The soils contain more calcium and magnesium, suggesting that the soils of the western Rim are younger than either the eastern Rim or the Cumberland Plateau. The western Rim has the same forest species as the eastern Rim, but much more of it is forested.

Methods

Fifty-six soil sampling pits were established on the Cumberland Plateau, 34 on the eastern Rim, and 24 on the western Rim. The pits are in Bledsoe, Franklin, Hickman, Marion, and Stewart Counties in Tennessee. Soil descriptions were taken according to procedures of the Soil Conservation Service (1951). Field determinations of texture, rather than the separate laboratory determinations presented in the tables, were used in preparing the description. The classification of the soil series presented here has been verified by the Soil Conservation Service.

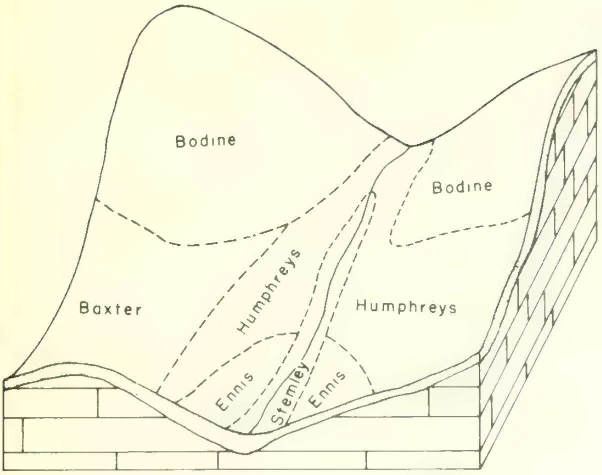

Figure 4.—*Soil series-landscape relationships of the western Highland Rim.*

Undisturbed core samples were taken for all horizons below the A1 except where it proved impossible because the soil was too loose or too stony. Disturbed samples were taken for all horizons. Bulk density was determined from the undisturbed cores. Field capacity moisture retention was measured with undisturbed cores drained under 1/3 Bar pressure on a ceramic plate. Permanent wilting point moisture retention was measured by draining a disturbed sample under 15 Bar pressure on a pressure membrane. Texture analysis was by the revised Bouyoucos hydrometer method (Day 1965).

Total nitrogen was determined by the macro-Kjeldahl procedure (Bremner 1965), available phosphorus was colorimetrically determined by a 1*N* ammonium floride extraction (Jackson 1958) and organic matter was determined by the potassium dichromate method (Jackson 1958). A glass electrode and pH meter were used to obtain a 1:1 soil in water pH reading. Exchangeable aluminum and hydrogen were determined by titration with sodium hydroxide and back titration with potassium floride (McLean 1965). Exchangeable basic cations were extracted by 1*N* ammonium acetate at pH 7: calcium and magnesium were determined by the atomic absorption technique (Perkin Elmer Corp. 1968) and exchangeable potassium and sodium by flame photometry (Beckman Instruments Corp. 1964). Cation exchange capacity (CEC) was obtained by the sum of cations and base saturation by dividing total cations by CEC.

Results and Conclusion

Seventeen soil series found in forested areas of the Cumberland Plateau, eastern and western Highland Rim areas of Tennessee are represented by a typifying profile description followed on the facing page by a table of chemical and physical data (tables 1-17). The organic carbon, carbon to nitrogen ratio, and total porosity value can be calculated from the data presented. Per acre profile content of several important nutrients is listed (table 18).

These forest soils data can help a land manager assess the ability of a soil to fill a specific need. For example, a soil with a shallow fragipan may be good for growing pine, but poor for growing high value hardwoods. A landuser often knows the soil requirements of his intended use but not the properties of a soil he hopes will fill those needs. If the landuser can identify a soil series, the data we have presented provide him with chemical and physical information about that soil series as it occurs on the Cumberland Plateau and Highland Rim.

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CUMBERLAND PLATEAU PHYSIOGRAPHIC PROVINCE

CLIFTY SERIES

Classification: Fine-loamy, mixed*, mesic Fluventic Dystrochrepts

Typical Profile:

A1 -- 0-3" -- Very dark brown (10 YR 2/2) loam; weak medium granular structure; loose; abundant fine and medium roots; very strongly acid; abrupt wavy boundary. (2 to 8 inches thick)

A2 -- 3-10" -- Grayish brown (10 YR 5/2) silt loam; weak medium subangular blocky structure; very friable; abundant fine and medium few large roots; very strongly acid; clear wavy boundary. (0 to 15 inches thick)

B1 -- 10-22" -- Dark yellowish brown (10 YR 4/4) silt loam; weak medium subangular blocky structure; very friable; plentiful medium, few large roots; thin discontinuous clay films on ped faces; very strongly acid; clear wavy boundary. (0 to 14 inches thick)

B21 -- 22-33" -- Yellowish brown (10 YR 5/4) loam; moderate medium and coarse subangular blocky structure; friable; few medium roots; common thin clay films on ped faces; very strongly acid; clear wavy boundary. (6 to 15 inches thick)

B22 -- 33-41" -- Yellowish brown (10 YR 5/5) sandy loam; few medium distinct pale brown (10 YR 6/3) mottles; moderate medium and coarse angular blocky structure; friable; few fine and medium roots; common thin clay films on ped faces; very strongly acid; clear wavy boundary. (0 to 22 inches thick)

C -- 41-60" -- Yellowish brown (10 YR 5/6) gravelly sandy loam; common medium distinct light gray (10 YR 7/2) and pale brown (10 YR 6/3); few medium distinct reddish brown (5 YR 5/3) mottles; weak fine and medium subangular blocky structure; very friable; about 20 percent coarse fragments; very strongly acid; abrupt wavy boundary. (6 to 42 inches thick)

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* Based on associated soils and parent materials, these soils would not be expected to have enough weatherable minerals for the mixed family. Thus they are siliceous taxadjuncts to the Clifty Series.

Table 1.--Chemical and physical properties of 13 profiles of the Clifty Series

Horizon		Exchangeable K	Exchangeable Mg	Exchangeable Ca	Exchangeable Al	Cation Exchange Capacity
		Meq per 100g				
A1	average	.98	.49	1.64	2.49	6.45
	range	.63-1.40	.18-1.10	.34-4.30	1.03-3.50	4.68-9.43
A2	average	.74	.11	.22	2.40	4.05
	range	.18-1.19	.06-.20	.14-.35	1.62-3.01	2.86-4.66
B1	average	.18	.13	.26	2.60	3.68
	range	.09-.59	.04-.31	.10-.28	1.77-3.24	2.34-4.54
B21	average	.13	.19	.20	2.86	3.90
	range	.10-.17	.06-.46	.13-.30	1.83-3.75	2.79-5.13
B22	average	.12	.17	.21	3.17	4.07
	range	.09-.15	.11-.23	.10-.29	2.27-4.41	3.16-5.39
C	average	.09	.16	.19	2.72	3.55
	range	.05-.14	.09-.25	.08-.34	2.16-3.39	2.86-4.61

Horizon		Base Saturation	Organic Matter	Total N	Available P	pH
		Percent			ppm	
A1	average	48	10.3	.28	9.33	4.9
	range	31-78	7.3-13.6	.20-.48	5.25-22.75	4.7-5.3
A2	average	31	2.7	.11	.64	5.0
	range	21-38	1.5-3.5	.07-.13	.35-1.05	4.7-5.3
B1	average	16	1.4	.08	.86	5.1
	range	9-44	.5-2.9	.04-.12	.35-1.75	4.8-5.3
B21	average	15	.9	.06	.51	5.1
	range	10-22	.4-1.9	.04-.09	<.14-1.05	4.8-5.4
B22	average	13	.6	.05	.41	5.1
	range	9-17	.3-1.2	.04-.07	<.14-1.05	4.8-5.3
C	average	13	.5	.05	.41	5.1
	range	10-18	.1-1.5	.03-.08	<.14-.70	4.8-5.4

Horizon		Sand	Silt	Clay	Moisture Holding Capacity 1/3 Bar	Moisture Holding Capacity 15 Bar	Bulk Density
		Percent			Percent by Weight		g/cm³
A1	average	39	42	19	- - -	16.0	- - -
	range	26-50	32-52	14-22	- - -	9.2-30.1	- - -
A2	average	28	46	26	30.5	8.6	1.15
	range	16-48	30-56	20-34	24.3-38.1	6.4-11.3	1.02-1.39
B1	average	27	45	28	26.3	8.7	1.26
	range	16-58	22-56	20-32	17.5-34.3	6.4-10.7	1.12-1.43
B21	average	28	43	29	25.0	9.0	[illegible]
	range	16-46	30-54	20-34	17.5-31.5	6.5-11.5	1.25-1.63
B22	average	35	38	27	22.0	8.3	1.61
	range	20-46	28-48	20-32	17.0-29.2	6.5-9.8	1.45-1.76
C	average	45	32	23	20.2	7.1	1.67
	range	22-60	22-46	16-32	16.0-30.2	5.5-9.8	1.38-1.78

EALY SERIES

Classification: Coarse-loamy, siliceous, mesic Fluventic Dystrochrepts

Typical Profile:

A1 -- 0-2" -- Dark brown (10 YR 3/3) silt loam; weak fine granular structure; loose; abundant fine and medium roots; strongly acid; clear smooth boundary. (2 to 3 inches thick)

A2 -- 2-6" -- Dark yellowish brown (10 YR 4/4) silt loam; weak fine and medium subangular blocky structure; very friable; abundant fine and medium, few coarse roots; 5 to 10 percent chert fragments; strongly acid; clear wavy boundary. (3 to 5 inches thick)

B2 -- 6-17" -- Yellowish brown (10 YR 5/6) silt loam; weak medium and coarse subangular blocky structure; very friable; abundant fine and medium, few coarse roots; thin discontinuous clay films on ped faces; about 3 percent chert fragments; strongly acid; gradual wavy boundary. (9 to 11 inches thick)

C -- 17-38" -- Strong brown (7.5 YR 5/8) sand; weak medium subangular blocky structure; loose; few fine and medium roots; 20 to 40 percent chert fragments; strongly acid. (16 to 23 inches thick)

R -- 38" -- Acid sandstone.

Table 2.--Several chemical and physical properties of 1 profile of the Ealy Series

Horizon	Exchangeable				Cation Exchange Capacity
	K	Mg	Ca	Al	
	Meq per 100g				
A1	.86	.46	3.28	.46	5.47
A2	.76	.08	.25	1.06	2.44
B2	.09	.10	.40	1.15	1.91
C	.05	.14	.35	.82	1.53

Horizon	Base Saturation	Organic Matter	Total N	Available P	pH
	Percent			ppm	
A1	87	7.2	.21	8.05	5.5
A2	50	2.6	.10	1.05	5.1
B2	32	1.1	.07	1.05	5.2
C	37	.7	.07	2.45	5.3

Horizon	Sand	Silt	Clay	Moisture Holding Capacity		Bulk Density
				1/3 Bar	15 Bar	
	Percent			Percent by Weight		g/cm^3
A1	56	30	14	- - -	14.7	- - -
A2	44	36	20	19.2	5.9	1.21
B2	60	22	18	13.5	4.8	1.30
C	78	12	10	- - -	3.0	- - -

LONEWOOD SERIES, RED VARIANT

Classification: Fine-loamy, siliceous, mesic Typic Hapludults

Typical Profile:

A1 -- 0-4" -- Dark grayish brown (10 YR 4/2) sandy loam; weak coarse and very coarse granular; very friable; abundant fine, plentiful medium roots; 3 percent coarse fragments; very strongly acid; clear wavy boundary. (2 to 4 inches thick)

A2 -- 4-11" -- Yellowish brown (10 YR 5/4) sandy loam; weak medium and coarse subangular blocky structure; abundant fine, plentiful medium roots; 2 percent coarse fragments; very strongly acid; clear wavy boundary. (3 to 9 inches thick)

B21t -- 11-19" -- Yellowish red (5 YR 4/6) sandy clay loam; moderate fine and medium subangular blocky structure; friable; abundant fine, plentiful medium roots; thin patchy clay films on ped faces; 1 percent coarse fragments; strongly acid; clear wavy boundary. (0 to 10 inches thick)

B22t -- 19-31" -- Yellowish red (5 YR 4/8) sandy clay loam; strong medium, coarse and very coarse angular blocky structure; friable; plentiful fine and medium roots; thin common clay films on ped faces; 1 percent coarse fragments; strongly acid; gradual wavy boundary. (7 to 15 inches thick)

B23t -- 31-42" -- Red (2.5 YR 4/6) sandy loam; strong medium, coarse and very coarse angular blocky structure; friable; plentiful fine roots; moderately thick common clay films on ped faces; strongly acid; gradual wavy boundary. (0 to 15 inches thick)

B3 -- 42-68" -- Red (2.5 YR 4/8) loamy sand; moderate medium and coarse subangular blocky structure; friable; few fine roots; thin patchy clay films on ped faces; strongly acid; abrupt wavy boundary. (20 to 26 inches thick)

R -- 68" -- Partially weathered acid sandstone.

Table 3.--Chemical and physical properties of 2 profiles* of the Lonewood, Red Variant

Horizon	Exchangeable K	Exchangeable Mg	Exchangeable Ca	Exchangeable Al	Cation Exchange Capacity
	Meq per 100g				
A1 average	.89	.27	1.05	1.60	4.46
A2 average	.56	.09	.26	1.28	2.48
B21t average	.17	.42	.41	4.38	5.90
B22t average	.17	.83	.27	4.55	6.65
B23t average	.12	.29	.13	4.00	5.60
B3 average	.08	.14	.11	3.22	4.44

Horizon	Base Saturation	Organic Matter	Total N	Available P	pH
	Percent			ppm	
A1 average	52	11.0	.11	5.78	4.8
A2 average	41	1.9	.05	1.92	5.0
B21t average	18	.7	.05	.14	5.0
B22t average	20	.4	.04	.14	5.2
B23t average	12	.2	.04	.28	5.4
B3 average	10	.3	.03	.21	5.4

Horizon	Sand	Silt	Clay	Moisture Holding Capacity 1/3 Bar	Moisture Holding Capacity 15 Bar	Bulk Density
	Percent			Percent by Weight		g/cm^3
A1 average	55	29	16	- - -	7.6	- - -
A2 average	50	31	19	17.8	4.8	1.34
B21t average	42	27	34	20.9	11.4	1.42
B22t average	43	18	39	25.2	14.3	1.47
B23t average	47	14	39	24.2	14.2	1.60
B3 average	59	5	36	21.2	11.8	1.64

*Range not meaningful

GILPIN SERIES

Classification: Fine-loamy, mixed, mesic Typic Hapludults

Typical Profile:

A1 -- 0-1" -- Dark grayish brown (10 YR 4/2) silt loam; weak medium granular structure; very friable; plentiful fine roots; 13 percent coarse fragments; extremely acid; clear smooth boundary. (1 to 4 inches thick)

A2 -- 1-8" -- Yellowish brown (10 YR 5/4) silt loam; moderate medium granular structure; very friable; plentiful fine and medium roots; 1 percent coarse fragments; very strongly acid; clear smooth boundary. (3 to 7 inches thick)

B21t -- 8-15" -- Yellowish brown (10 YR 5/6) silt loam; moderate medium subangular blocky structure; friable; plentiful fine roots; thin discontinuous clay films on ped faces; 13 percent coarse fragments; very strongly acid; clear smooth boundary. (4 to 11 inches thick)

B22t -- 15-20" -- Yellowish brown (10 YR 5/6) gravelly silty clay loam; moderate medium subangular blocky structure; friable; few fine roots; common moderately thick clay films on ped faces; about 15 percent coarse fragments; strongly acid; gradual smooth boundary. (5 to 9 inches thick)

B3 & C -- 20-28" -- Yellowish brown (10 YR 5/4) very gravelly silty clay loam; weak medium subangular blocky structure; friable; more than 50 percent coarse fragments; strongly acid; abrupt smooth boundary. (0-9 inches thick)

Table 4.--Chemical and physical properties of 7 profiles of the Gilpin Series

Horizon		Exchangeable K	Exchangeable Mg	Exchangeable Ca	Exchangeable Al	Cation Exchange Capacity
		Meq per 100g				
A1	average	.56	.43	3.39	2.29	6.43
	range	.20-.88	.19-.78	.69-3.64	1.49-3.19	4.02-8.17
A3	average	.31	.06	.15	2.08	2.92
	range	.09-.43	.05-.07	.12-.21	1.58-2.58	2.67-3.70
B21t	average	.26	.13	.34	3.13	4.21
	range	.10-.31	.07-.21	.13-.58	2.42-3.71	3.39-5.42
B22t	average	.24	.31	.37	4.36	5.78
	range	.11-.39	.15-.55	.18-.55	2.94-6.23	4.31-7.36
B3	average	.31	.35	.39	4.98	6.50
	range	.17-.42	.18-.45	.20-.63	2.63-7.72	4.38-9.72
C	average	.25	.24	.23	4.71	6.16
	range	.19-.30	.23-.25	.10-.35	2.21-7.21	4.99-8.33

Horizon		Base Saturation	Organic Matter	Total N	Available P	pH
		Percent			ppm	
A1	average	48	7.6	.19	6.00	4.6
	range	27-73	4.4-10.7	.12-.26	2.80-9.80	4.4-4.9
A3	average	20	1.5	.06	1.33	5.0
	range	10-24	1.1-2.1	.05-.07	.35-2.10	4.9-5.0
B21t	average	18	.8	.05	approx. .73	5.1
	range	11-24	.4-1.2	.04-.06	<.14-1.4	5.0-5.2
B22t	average	18	.5	.05	approx. 15	5.3
	range	7-28	.4-.8	.03-.06	<.14-.70	5.1-5.4
B3	average	18	.3	.04	<.14	5.4
	range	10-33	.2-.6	.03-.05	<.14-.35	5.2-5.6
C	average	15	.4	.05	<.14	5.4
	range	6-24	.2-.5	.04-.06	---	5.2-5.6

Horizon		Sand	Silt	Clay	Moisture Holding Capacity 1/3 Bar	Moisture Holding Capacity 15 Bar	Bulk Density
		Percent			Percent by Weight		g/cm^3
A1	average	25	57	16	- - -	10.2	- - -
	range	4-40	44-78	12-28	- - -	7.0-13.8	- - -
A3	average	23	56	23	24.9	6.0	1.40
	range	16-28	40-62	20-28	22.8-25.5	5.2-6.8	1.33-1.49
B21t	average	24	48	28	23.7	8.9	1.47
	range	16-38	34-56	24-30	22.4-25.7	7.5-9.6	1.40-1.53
B22t	average	28	41	31	24.7	12.1	1.53
	range	18-42	32-46	24-44	23.0-26.4	6.6-17.0	1.36-1.62
B3	average	34	32	33	24.3	13.2	1.56
	range	28-46	22-48	24-42	19.8-30.2	6.2-18.2	1.46-1.68
C	average	32	33	35	- - -	13.8	- - -
	range	22-42	28-38	30-40	- - -	12.7-15.0	- - -

HARTSELLS SERIES

Classification: Fine-loamy, siliceous, thermic* Typic Hapludults

Typical Profile:

A1 -- 0-1" -- Dark gray (10 YR 4/1) loam; weak medium granular structure; very friable; abundant fine and medium roots; 3 percent coarse fragments; strongly acid; abrupt smooth boundary. (1 to 4 inches thick)

A2 -- 1-7" -- Yellowish brown (10 YR 5/4) fine sandy loam; weak medium subangular blocky structure; friable; abundant medium and large roots; 4 percent coarse fragments; strongly acid; clear wavy boundary. (3 to 11 inches thick)

B21 -- 7-17" -- Yellowish brown (10 YR 5/6) fine sandy loam; weak medium subangular blocky structure; friable; plentiful medium and large roots; 3 percent coarse fragments; very strongly acid; gradual wavy boundary. (6 to 12 inches thick)

B22t -- 17-24" -- Yellowish brown (10 YR 5/6) very fine sandy loam; moderate medium and coarse subangular blocky structure; very friable; plentiful medium roots; common thin clay films on ped faces; 2 percent coarse fragments; very strongly acid; gradual wavy boundary. (0 to 13 inches thick)

C -- 24-31" -- Yellowish brown (10 YR 5/8) sandy loam; moderate medium subangular blocky; friable; few medium roots; thin continuous clay films on ped faces; 10 percent coarse fragments; very strongly acid; abrupt wavy boundary. (0 to 19 inches thick)

R -- 31" -- Partially weathered acid sandstone.

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* These soils have mesic temperatures and are taxadjuncts to the Hartsells Series.

Table 5.--Chemical and physical properties of 15 profiles of the Hartsells Series

Horizon		Exchangeable				Cation Exchange Capacity
		K	Mg	Ca	Al	
		Meq per 100g				
A1	average	1.08	.56	2.93	1.72	7.07
	range	.66-1.46	.23-.92	.75-6.93	.02-6.30	4.90-11.63
A2	average	.68	.09	.23	1.59	3.07
	range	.31-1.44	.04-.15	.12-.58	.10-2.40	1.33-5.42
B21	average	.13	.16	.28	2.58	3.53
	range	.08-.20	.08-.34	.13-.44	1.30-3.90	1.95-5.16
B22t	average	.12	.35	.22	2.81	3.88
	range	.08-.18	.10-.70	.10-.40	2.05-3.90	2.83-4.87
C	average	.10	.30	.17	2.88	3.92
	range	.05-.18	.12-.52	.07-.31	.14-3.90	1.96-5.62

Horizon		Base Saturation	Organic Matter	Total N	Available P	pH
		Percent			ppm	
A1	average	67	12.3	.26	14.28	5.0
	range	34-95	6.3-22.1	.15-.44	5.60-22.05	4.4-5.5
A2	average	39	2.7	.08	1.86	5.0
	range	24-71	1.6-4.2	.05-.18	1.05-3.85	4.7-5.3
B21	average	18	.9	.05	.88	4.9
	range	9-36	.5-1.2	.04-.06	.35-1.75	4.7-5.2
B22t	average	19	.5	.04	.50	5.0
	range	15-23	.3-.8	.03-.05	.14-1.75	4.8-5.3
C	average	17	.3	.02	approx. .43	5.2
	range	11-27	.1-.6	.01-.04	<.14-1.54	4.9-5.5

Horizon		Sand	Silt	Clay	Moisture Holding Capacity		Bulk Density
					1/3 Bar	15 Bar	
		Percent			Percent by Weight		g/cm^3
A1	average	58	24	18	- - -	14.0	- - -
	range	44-66	18-32	12-38	- - -	7.7-24.3	- - -
A2	average	53	26	21	19.5	5.7	1.29
	range	39-66	18-37	16-26	16.4-24.6	3.6-7.9	1.11-1.43
B21	average	50	25	25	18.0	7.0	1.41
	range	37-60	16-32	20-32	14.3-22.0	4.4-10.5	1.32-1.65
B22t	average	55	21	24	18.3	7.6	1.63
	range	34-64	12-34	20-32	15.5-22.4	5.4-11.4	1.58-1.73
C	average	64	13	23	18.0	7.4	1.73
	range	54-78	8-20	12-34	15.9-20.2	3.3-12.0	1.64-1.83

LINKER SERIES

Classification: Fine-loamy, siliceous, thermic* Typic Hapludults

Typical Profile:

A1 -- 0-3" -- Dark grayish brown (10 YR 4/2) fine sandy loam; weak medium, coarse and very coarse granular structure; very friable; abundant fine, plentiful medium roots; 12 percent sandstone fragments; very strongly acid; clear wavy boundary. (1 to 4 inches thick)

A2 -- 3-9" -- Reddish yellow (7.5 YR 6/6) gravelly sandy loam; weak medium subangular blocky structure; very friable; abundant fine, plentiful medium roots; 16 percent sandstone fragments; very strongly acid; clear wavy boundary. (5 to 7 inches thick)

B21t -- 9-15" -- Strong brown (7.5 YR 5/6) gravelly sandy clay loam; weak medium and coarse subangular blocky structure; friable; abundant fine, few medium roots; thin patchy clay films on ped faces; 15 percent sandstone fragments; very strongly acid; clear wavy boundary (4 to 7 inches thick)

B22t -- 15-24" -- Yellowish red (5 YR 5/8) sandy clay loam; moderate medium coarse angular blocky structure; friable; plentiful fine, few medium roots; thin common clay films on ped faces; 14 percent sandstone fragments; strongly acid; abrupt wavy boundary. (9 to 20 inches thick)

B3 -- 24-33" -- Yellowish red (5 YR 4/6) sandy loam; moderate medium platy breaking to moderate medium and coarse angular blocky structure; firm; few fine roots; thin common clay films on ped faces; 1 percent sandstone fragments; medium acid; abrupt wavy boundary. (3 to 10 inches thick)

R -- 33" -- Acid sandstone.

* These soils have mesic temperatures and are taxadjuncts to the Linker Series.

Table 6.--Chemical and physical properties of 2 profiles* of the Linker Series

Horizon	Exchangeable K	Exchangeable Mg	Exchangeable Ca	Exchangeable Al	Cation Exchange Capacity
	Meq per 100g				
A1 average	1.08	.34	.99	2.08	5.04
A2 average	.81	.13	.14	1.00	[illegible].50
B21t average	.11	.07	.16	2.45	3.24
B22t average	.11	.22	.18	2.48	[illegible].51
B3 average	.05	.23	.14	2.05	[illegible].82

Horizon	Base Saturation	Organic Matter	Total N	Available P	pH
	Percent			ppm	
A1 average	51	10.8	.21	8.22	5.1
A2 average	47	1.4	.06	3.15	5.0
B21t average	17	1.1	.06	.35	4.9
B22t average	22	.8	.04	.21	5.4
B3 average	17	.3	.02	.14	5.5

Horizon	Sand	Silt	Clay	Moisture Holding Capacity 1/3 Bar	Moisture Holding Capacity 15 Bar	Bulk Density
	Percent			Percent by Weight		[illegible]
A1 average	66	22	12	- - -	10.0	- -
A2 average	61	22	17	14.6	4.8	1.41
B21t average	51	20	29	16.3	8.8	1.39
B22t average	53	17	30	18.7	10.3	1.51
B3 average	63	8	29	- - -	10.1	- -

*Range not meaningful

LONEWOOD SERIES

Classification: Fine-loamy, siliceous, mesic Typic Hapludults

Typical Profile:

A1 -- 0-1" -- Dark grayish brown (10 YR 4/2) loam; weak fine and medium granular structure; loose; abundant fine and medium roots; strongly acid; abrupt smooth boundary. (1 to 5 inches thick)

A2 -- 1-6" -- Brown (10 YR 4/3) silt loam; moderate medium and coarse subangular blocky structure; friable; abundant fine and medium roots; very strongly acid; clear wavy boundary. (4 to 8 inches thick)

B1 -- 6-14" -- Yellowish brown (10 YR 5/4) silty clay loam; moderate medium and coarse subangular blocky structure; friable; abundant fine and medium, few large roots; very strongly acid; clear wavy boundary. (5 to 9 inches thick)

B21t -- 14-24" -- Dark yellowish brown (10 YR 4/4) silty clay loam; strong medium, coarse, and very coarse angular blocky structure; friable; plentiful medium, few large roots; many moderately thick clay films on ped faces; very strongly acid; clear wavy boundary. (5 to 14 inches thick)

B22t -- 24-33" -- Dark yellowish brown (10 YR 4/4) silty clay loam; strong coarse and very coarse angular blocky structure; firm; plentiful medium, few large roots; many moderately thick clay films on ped faces; strongly acid; clear wavy boundary. (5 to 14 inches thick)

C -- 33-50" -- Light yellowish brown (10 YR 6/4) sandy loam; few fine distinct yellowish brown (10 YR 5/6) mottles; strong medium, coarse and very coarse angular blocky structure; friable; few fine roots; very strongly acid; gradual wavy boundary. (10 to 42 inches thick)

Table 7.--Chemical and physical properties of 15 profiles of the Lonewood Series

Horizon		Exchangeable K	Exchangeable Mg	Exchangeable Ca	Exchangeable Al	Cation Exchange Capacity
		Meq per 100g				
A1	average	1.01	.73	3.28	1.81	7.29
	range	.69-1.41	.32-1.45	1.26-8.86	.55-2.75	5.16-12.74
A2	average	.64	.10	.22	1.87	3.22
	range	.15-.89	.06-.16	.14-.46	1.21-2.75	2.48-4.22
B1	average	.21	.20	.32	2.47	3.71
	range	.06-.54	.05-.44	.11-.56	1.15-3.95	1.55-5.62
B21t	average	.13	.25	.23	2.96	3.96
	range	.06-.19	.04-.78	.14-.46	1.48-5.10	1.98-6.32
B22t	average	.13	.35	.18	3.17	4.29
	range	.06-.24	.08-.96	.09-.38	1.54-5.45	2.08-6.80
C	average	.12	.21	.18	3.23	4.12
	range	.05-.27	.12-.32	.10-.35	1.97-5.20	2.46-6.36

Horizon		Base Saturation	Organic Matter	Total N	Available P	pH
		Percent			ppm	
A1	average	66	13.1	.26	13.73	4.9
	range	43-92	7.8-24.0	.04-.58	7.35-23.80	4.6-5.3
A2	average	34	3.3	.09	1.92	5.0
	range	16-55	1.2-4.6	.06-.18	.70-5.95	4.8-5.3
B1	average	21	1.3	.07	1.14	5.0
	range	16-27	.8-2.4	.05-.09	.42-1.54	4.8-5.2
B21t	average	17	.83	.05	.79	5.0
	range	11-25	.4-1.7	.04-.06	.28-1.40	4.9-5.1
B22t	average	17	.4	.04	.42	5.1
	range	9-33	.1-.6	.02-.05	.14-1.40	4.9-5.4
C	average	14	.2	.02	.46	5.2
	range	9-18	.1-.4	.01-.05	.14-1.40	5.0-5.6

Horizon		Sand	Silt	Clay	Moisture Holding Capacity 1/3 Bar	Moisture Holding Capacity 15 Bar	Bulk Density
		Percent			Percent by Weight		g/cm
A1	average	51	30	19	- - -	14.5	- - -
	range	26-62	14-46	14-36	- - -	7.6-28.0	- - -
A2	average	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	range	28-58	20-48	20-32	17.7-35.1	4.4-11.8	1.07-1.44
B1	average	39	34	27	20.7	7.8	1.32
	range	28-54	18-42	20-34	18.8-24.2	5.0-9.7	1.17-1.48
B21t	average	43	30	27	20.2	7.9	1.43
	range	28-58	16-42	20-34	16.1-24.8	5.1-11.3	1.20-1.63
B22t	average	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	range	30-66	12-44	20-32	14.8-22.4	5.2-11.2	1.44-1.74
C	average	53	21	26	18.5	8.3	1.73
	range	40-68	8-34	16-34	13.7-24.8	6.0-12.8	1.59-1.85

TILSIT SERIES

Classification: Fine-silty, mixed*, mesic Typic Fragiudults

Typical Profile:

A1 -- 0-2" -- Very dark brown (10 YR 2/2) silt loam; moderate medium granular; very friable; abundant fine roots; 3 percent coarse fragments; very strongly acid; clear smooth boundary.

A2 -- 2-6" -- Light grayish brown (10 YR 6/2) silt loam; common medium distinct yellowish brown (10 YR 5/6) mottles; weak medium granular structure; very friable; plentiful fine and medium roots; 2 percent coarse fragments; very strongly acid; clear smooth boundary.

B1 -- 6-13" -- Light yellowish brown (10 YR 6/4) silt loam; weak medium subangular blocky structure; friable; plentiful fine and medium roots; 1 percent coarse fragments; clear smooth boundary.

B2t -- 13-21" -- Yellowish brown (10 YR 5/6) silt loam; moderate medium subangular blocky structure; firm; plentiful, fine and medium roots; thin patchy clay films on ped faces; 1 percent coarse fragments; strongly acid; clear smooth boundary.

Bx1 -- 21-29" -- Brown (10 YR 5/3) light grayish brown (10 YR 6/2) and dark brown (10 YR 4/3) silt loam; moderate medium subangular and angular blocky structure; brittle, very firm; thin patchy clay films on ped faces; 3 percent coarse fragments; strongly acid; gradual smooth boundary.

Bx2 -- 29-55" -- Yellowish brown (10 YR 5/6) dark yellowish brown (10 YR 4/4) and pale brown (10 YR 6/3) silt loam; moderate medium angular blocky structure; brittle, very firm; thin patchy clay films on ped faces; silt flows between peds; 17 percent coarse fragments; strongly acid; gradual smooth boundary.

R -- 55" -- Acid sandstone bedrock.

* Based on associated soils and parent materials, these soils would not be expected to have enough weatherable minerals for the mixed family. Thus, they are siliceous taxadjuncts to the Clifty Series.

Table 8.--Chemical and physical properties of 1 profile of the Tilsit Series

Horizon	Exchangeable				Cation Capacity
	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]				
A1	.47	.35	1.[illegible]	2.53	5.48
A2	.47	.06	.20	2.41	3.33
B1	.26	.14	.36	[illegible]	5.47
B2t	.37	.36	.52	4.64	6.27
Bx1	.35	.25	[illegible]	4.02	5.50
BX2	.34	.19	.32	4.17	5.34

Horizon	Base Saturation	Organic Matter	Total N	Available [illegible]	pH
	- - - - - - - -	Percent - - -	- - -	[illegible]	
A1	44	8.3	.25	3.85	4.8
A2	24	1.9	.06	.70	4.9
B1	15	.9	.05	.35	5.0
B2t	21	.5	.04	.18	5.2
Bx1	21	.2	.02	< .14	5.2
Bx2	15	.1	.02	< .14	5.2

Horizon	Sand	Silt	Clay	Moisture Holding Capacity 1/3 Bar	Moisture Holding Capacity 15 Bar	Bulk Density
	- - - - -	Percent - - -	-	Percent by Weight		[illegible]
A1	26	58	16	- - -	9.2	- - -
A2	20	60	20	27.5	4.8	1.41
B1	16	56	28	24.8	8.3	[illegible]
B2t	22	52	26	24.3	8.1	1.56
Bx1	28	52	20	20.7		1.69
Bx2	34	46	20	- - -	5.6	

EASTERN HIGHLAND RIM PHYSIOGRAPHIC SUBPROVINCE

DEWEY SERIES

Classification: Clayey, kaolinitic, thermic Typic Paleudults

Typical Profile:

A1 -- 0-3" -- Dark grayish brown (10 YR 4/2) silt loam; weak fine granular structure; very friable; abundant fine and medium roots; 5 percent coarse fragments; strongly acid; clear wavy boundary. (3 to 4 inches thick)

A2 -- 3-8" -- Brown (7.5 YR 5/4) silt loam; moderate fine and medium subangular blocky structure; very friable; abundant fine, medium and large roots; 8 percent coarse fragments; strongly acid; clear wavy boundary. (5 to 8 inches thick)

B1 -- 8-14" -- Yellowish brown (10 YR 5/5) silt loam; moderate fine and medium subangular blocky structure; friable; plentiful fine and medium roots; 8 percent coarse fragments; strongly acid; clear wavy boundary. (6 to 7 inches thick)

B21t -- 14-21" -- Strong brown (7.5 YR 5/6) silty clay loam; moderate fine and medium subangular blocky structure; friable; abundant fine, few medium roots; thin discontinuous clay films on ped faces; 6 percent coarse fragments; strongly acid; gradual smooth boundary. (6 to 8 inches thick)

B22t -- 21-28" -- Strong brown (7.5 YR 5/6) clay loam; moderate fine and medium angular blocky structure; firm; few medium roots; thin discontinuous clay films on ped faces; 5 percent coarse fragments; strongly acid; gradual smooth boundary. (7 to 11 inches thick)

B23t -- 28-39" -- Strong brown (7.5 YR 5/6) clay loam; common medium distinct yellowish red (5 YR 5/6) and common medium distinct pale brown (10 YR 6/3) mottles; moderate fine and medium angular blocky structure; firm; few medium roots; common moderately thick clay films on ped faces; 10 percent coarse fragments; strongly acid; abrupt smooth boundary. (11 to 19 inches thick)

IIB24t -- 39-54" -- Dark red (2.5 YR 3/6) clay; yellowish brown (10 YR 5/6) streaks; moderate fine and medium subangular blocky structure; firm; few medium roots; strongly acid; abrupt smooth boundary. (13 to 16 inches thick)

Table 9.--Chemical and physical properties of 3 profiles* of the Dewey Series

Horizon	Exchangeable K	Exchangeable Mg	Exchangeable Ca	Exchangeable Al	Cation Exchange Capacity
	- - - - - - - - - - - - -	Meq per 100g	- - - - - - - -	- - - - - - -	
A1 average	1.46	.37	1.49	.76	4.63
A2 average	.88	.26	.52	1.10	3.30
B1 average	.15	.51	.62	2.41	4.17
B21t average	.16	.72	.41	4.28	6.04
B22t average	.15	.76	.27	6.38	8.28
B23t average	.15	.65	.30	7.38	9.26

Horizon	Base Saturation	Organic Matter	Total N	Available P	pH
	- - - - - - - - -	Percent	- - - - - - -	ppm	
A1 average	77	4.8	.16	4.84	5.2
A2 average	55	1.3	.06	.93	5.2
B1 average	33	.7	.04	.35	5.1
B21t average	23	.4	.03	.35	5.2
B22t average	15	.3	.03	.35	5.4
B23t average	12	.3	.01	.18	5.2

Horizon	Sand	Silt	Clay	Moisture Holding Capacity 1/3 Bar	Moisture Holding Capacity 15 Bar	Density
	- - - - -	Percent	- - - - -	Percent by Weight		
A1 average	18	61	21	- - -	8.9	--
A2 average	13	58	29	22.7	6.3	[illegible]
B1 average	11	53	36	24.8	9.7	1.39
B21t average	8	47	46	24.8	13.8	1.50
B22t average	4	44	52	27.8	18.5	1.50
B23t average	6	38	56	31.1	20.2	1.44

*Range not meaningful

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DICKSON SERIES

Classification: Fine-silty, siliceous, thermic Glossic Fragiudults

Typical Profile:

A1 -- 0-2" -- Dark grayish brown (10 YR 4/2) silt loam; weak medium granular structure; very friable; abundant fine roots; 5 percent coarse fragments; strongly acid; abrupt smooth boundary. (2 to 4 inches thick)

A2 -- 2-6" -- Yellowish brown (10 YR 5/5) silt loam; moderate fine and medium subangular blocky structure; friable; many fine, plentiful medium roots; 4 percent coarse fragments; very strongly acid; clear smooth boundary. (4 to 8 inches thick)

B1 -- 6-17" -- Yellowish brown (10 YR 5/6) silt loam; moderate fine and medium subangular blocky structure; friable; plentiful fine and medium roots; 9 percent coarse fragments; strongly acid; gradual smooth boundary. (6 to 11 inches thick)

B2 -- 17-28" -- Yellowish brown (10 YR 5/5) silty clay loam; moderate fine and medium subangular blocky structure; friable; plentiful fine, few medium roots; strongly acid; clear wavy boundary. (4 to 11 inches thick)

B'x1 -- 28-42" -- Pale brown (10 YR 6/3) silty clay loam; common medium distinct reddish brown (5 YR 4/4) and light gray (10 YR 6/1) mottles; moderate coarse platy, moderate fine and medium angular blocky structure; brittle and firm; strongly acid; gradual wavy boundary. (7 to 14 inches thick)

B'x2 -- 42-54" -- Yellowish brown (10 YR 5/4) and reddish brown (5 YR 4/4) clay loam; moderate coarse platy and moderate fine and medium angular blocky; firm; veins of clay between peds; strongly acid; gradual wavy boundary. (6 to 12 inches thick)

IIB'2t -- 54-65" -- Yellowish red (5 YR 4/6) clay; common medium distinct light brownish gray (10 YR 6/2) to light yellowish brown (10 YR 6/4) mottles; moderate medium angular blocky structure; very firm; strongly acid; abrupt wavy boundary. (11 to 40 inches thick)

Table 10.--Chemical and physical properties of 8 profiles of the Dickson Series

Horizon		K	Mg	Ca	Al	Cation Exchange Capacity
		Meq per 100g				
A1	average	1.03	.36	1.85	1.35	5.21
	range	.82-1.26	.19-.71	.45-5.22	.27-2.73	4.19-5.51
A2	average	1.12	.12	.24	2.11	4.14
	range	.83-1.59	.06-.20	.10-.40	1.24-2.94	2.83-4.97
B1	average	.12	.26	.31	3.30	4.42
	range	.09-.18	.10-.54	.12-.58	2.75-3.66	4.17-4.76
B2	average	.10	.38	.26	4.01	5.23
	range	.07-.13	.16-.67	.09-.60	2.91-4.89	4.71-5.96
B'x1	average	.08	.40	.20	4.39	5.75
	range	.06-.10	.18-.69	.10-.94	3.15-5.27	4.08-7.18
B'x2	average	.08	.41	.27	6.34	7.70
	range	.06-.15	.20-.64	.06-.87	5.61-7.72	6.49-8.99
IIB'2t	average	.08	.39	.14	7.10	8.20
	range	.06-.10	.20-.54	.06-.22	6.49-8.05	7.40-8.93

Horizon		Base Saturation	Organic Matter	Total N	Available P	pH
		Percent			ppm	
A1	average	64	4.7	.15	5.62	4.9
	range	36-94	[illegible]	.11-.21	4.9-7.7	4.5-5.1
A2	average	42	1.2	.05	.70	4.9
	range	33-56	.7-1.7	.04-.07	.35-1.05	4.7-5.2
B1	average	17	.6	.04	.57	5.0
	range	8-29	.4-.8	.04-.05	.35-.70	4.8-5.2
B2	average	15	.4	.03	[illegible]	5.1
	range	7-30	.3-.5	.03	<.14-.35	5.0-5.2
B'x1	average	13	.2	.01	[illegible]	[illegible]
	range	8-28	.1-.3	.01-.03	<.14-.35	5.0-5.3
B'x2	average	10	.2		[illegible]	5.3
	range	6-20	.1-.2	- - -	<.14-.35	5.2-5.4
IIB'2t	average	8	.2	- -	< .14	5.4
	range	5-10	.1-.2	-	- - -	5.2-5.5

Horizon		Sand	Silt	Clay	Moisture Holding Capacity 1/3 Bar	15 Bar	Bulk Density
		Percent			Percent by Weight		
A1	average	15	68	17	- - -	9.2	
	range	10-20	62-74	14-20	- - -	6.4-13.4	
A2	average	10	65	25	25.	6.0	1.35
	range	2-20	60-70	20-28	22.4-29.	4.7-6.9	1.25-1.44
B1	average	8	61	31	24.2	8.4	1.42
	range	2-14	52-66	26-34	22.9-27.1	7.8-9.4	1.28-1.54
B2	average	10	60	30	22.0	8.7	1.62
	range	6-18	56-64	26-32	20.0-22.8	7.8-9.5	1.55-1.70
B'x1	average	11	57	32	20.[illegible]	9.2	1.67
	range	4-20	50-62	22-42	17.9-22.1	5.8-12.4	1.60-1.71
B'x2	average	13	47	40		13.8	
	range	6-22	42-54	32-52	- -	11.0-18.4	
IIB'2t	average	15	[illegible]	46		18.4	
	range	10-24	36-40	36-52	- -	15.8-20.8	

MOUNTVIEW SERIES

Classification: Fine-silty, siliceous, thermic Typic Paleudults

Typical Profile:

A1 -- 0-3" -- Grayish brown (10 YR 5/2) silt loam; weak fine granular structure; very friable; abundant fine; plentiful medium roots; 2 percent coarse fragments; strongly acid; clear wavy boundary. (2 to 4 inches thick)

A2 -- 3-9" -- Yellowish brown (10 YR 5/4) silt loam; moderate fine and medium subangular blocky structure; very friable; abundant fine and medium roots; 2 percent coarse fragments; strongly acid; clear smooth boundary. (5 to 7 inches thick)

B1 -- 9-18" -- Yellowish brown (10 YR 5/5) silt loam; moderate fine and medium subangular blocky structure; friable; plentiful fine and medium roots; thin discontinuous clay films on ped faces; 11 percent coarse fragments; strongly acid; clear smooth boundary. (6 to 10 inches thick)

B21t -- 18-33" -- Yellowish brown (10 YR 5/6) silt loam; moderate medium subangular blocky structure; friable; few fine and medium roots; thin discontinuous clay films on ped faces; 5 percent coarse fragments; strongly acid; gradual smooth boundary. (7 to 16 inches thick)

IIB22t -- 33-43" -- Strong brown (7.5 YR 5/6) silty clay loam; common medium distinct pale brown (10 YR 6/3) and brownish yellow (10 YR 6/8) mottles; moderate medium angular blocky structure; firm; very few fine roots; thin discontinuous clay films on ped faces; 7 percent coarse fragments; strongly acid; gradual smooth boundary. (8 to 11 inches thick)

IIB23t -- 43-61" -- Yellowish brown (10 YR 5/6) silty clay loam; many large distinct red (2.5 YR 4/6) mottles; moderate fine and medium subangular blocky structure; firm; 16 percent coarse fragments; strongly acid; gradual smooth boundary. (9 to 19 inches thick)

IIB24t -- 61-76" -- Red (2.5 YR 4/6) clay; common large distinct yellowish brown (10 YR 5/6) mottles; strong fine and medium subangular blocky structure; very firm; strongly acid.

Table 11.--Chemical and physical properties of 2 profiles* of the Mountview Series

Horizon		Exchangeable K	Exchangeable Mg	Exchangeable Ca	Exchangeable Al	Cation Exchange Capacity
		Meq per 100g				
A1	average	1.02	.46	2.08	.82	5.00
A2	average	.89	.14	.30	1.90	3.80
B1	average	.14	.38	.24	3.34	4.62
B21t	average	.14	.44	.28	4.16	5.50
IIB22t	average	.13	.48	.24	4.54	6.02
IIB23t	average	.10	.36	.11	5.77	7.12

Horizon		Base Saturation	Organic Matter	Total N	Available P	pH
		Percent	Percent	Percent	ppm	
A1	average	73	5.3	.16	6.74	5.1
A2	average	39	1.4	.06	1.22	5.1
B1	average	18	.6	.04	.52	5.1
B21t	average	16	.3	.04	.52	5.2
IIB22t	average	15	.2	.02	.35	5.2
IIB23t	average	9	.1	.01	<.14	5.4

Horizon		Sand	Silt	Clay	Moisture Holding Capacity 1/3 Bar	Moisture Holding Capacity 15 Bar	Bulk Density
		Percent	Percent	Percent	Percent by Weight	Percent by Weight	g/cm^3
A1	average	16	65	18	- - -	11.3	- - -
A2	average	7	66	27	25.8	7.1	1.25
B1	average	8	58	34	22.4	9.1	1.42
B21t	average	7	58	35	23.3	9.8	1.60
IIB22t	average	7	54	39	23.2	12.2	1.59
IIB23t	average	8	48	44	25.3	15.4	1.56

*Range not meaningful

TAFT SERIES

Classification: Fine-silty, siliceous, thermic Glossaquic Fragiudults

Typical Profile:

A1 -- 0-1" -- Dark grayish brown (10 YR 4/2) silt loam; weak medium granular structure; very friable; abundant fine roots; 1 percent coarse fragments; very strongly acid; abrupt wavy boundary. (1 to 3 inches thick)

A2 -- 1-7" -- Pale brown (10 YR 6/3) silt loam; weak medium subangular blocky structure; friable; abundant fine, few medium, plentiful large roots; very strongly acid; clear smooth boundary. (5 to 7 inches thick)

B1 -- 7-12" -- Reddish brown (2.5 YR 5/3) silt loam; moderate fine and medium subangular blocky structure; friable; plentiful fine, few medium roots; 1 percent coarse fragments; very strongly acid; clear smooth boundary. (5 to 9 inches thick)

B2 -- 12-20" -- Yellowish brown (10 YR 5/5) silty clay loam; common medium distinct light olive brown (2.5 YR 5/4) and common medium faint light brownish gray (2.5 YR 6/2) mottles; moderate medium subangular blocky structure; friable; very few fine, medium and large roots; 2 percent coarse fragments; very strongly acid; gradual wavy boundary. (5 to 10 inches thick)

B'x1 -- 20-28" -- Grayish brown (2.5 YR 5/2) silty clay loam; common medium distinct yellowish brown (10 YR 5/6) mottles; weak medium platy breaking to moderate medium angular blocky; firm; common thick light brownish gray (10 YR 6/2) clay films on ped faces, few clay columns between peds; 2 percent coarse fragments; strongly acid; gradual wavy boundary. (6 to 28 inches thick)

B'x2 -- 28-37" -- Light olive brown (2.5 YR 5/3) silty clay loam; common medium distinct gray (10 YR 6/1) and yellowish brown (10 YR 5/6) mottles; weak medium platy breaking to moderate medium angular blocky structure; firm; common thick clay films on ped faces; clear irregular boundary. (8 to 16 inches thick)

IIB'2t -- 37-62" -- Red (2.5 YR 5/8) to yellowish brown (10 YR 5/6) to gray (7.5 YR 5/0) to white (7.5 YR 8/0) clay; moderate medium subangular blocky structure; firm, abrupt broken boundary.

Table 12.--Chemical and physical properties of 6 profiles of the Taft Series

Horizon		Exchangeable K	Exchangeable Mg	Exchangeable Ca	Exchangeable Al	Cation Exchange Capacity
		Meq per 100g				
A1	average	1.07	.24	.78	2.21	5.34
	range	.94-1.21	.14-.34	.30-1.21	1.65-2.88	4.20-6.33
A2	average	1.02	.09	.17	2.65	4.46
	range	.78-1.21	.06-.13	.13-.22	1.71-3.60	3.45-5.83
B1	average	.07	.11	.14	3.27	4.05
	range	.05-.09	.06-.20	.10-.18	.24-3.81	3.09-4.76
B2	average	.07	.18	.13	3.74	4.55
	range	.04-.09	.09-.33	.07-.16	3.24-4.33	3.93-5.45
B'x1	average	.07	.22	.12	3.98	4.91
	range	.05-.08	.12-.42	.05-.25	3.35-5.00	4.17-6.43

Horizon		Base Saturation	Organic Matter	Total N	Available P	pH
		Percent	Percent	Percent	ppm	
A1	average	48	5.0	.15	5.78	4.6
	range	37-55	3.8-6.4	.12-.18	4.20-8.40	4.4-4.9
A2	average	34	1.2	.05	.54	4.8
	range	29-44	1.0-1.4	.04-.06	.35-.88	4.8-4.9
B1	average	9	.5	.04	.58	5.0
	range	8-11	.4-.8	.03-.04	.35-.70	4.9-5.1
B2	average	10	.4	.03	.41	5.1
	range	6-12	.2-.6	.02-.04	.35-.70	5.0-5.2
B'x1	average	10	.2	.01	.41	5.2
	range	6-12	.1-.4	.01-.03	.35-.70	5.1-5.2

Horizon		Sand	Silt	Clay	Moisture Holding Capacity 1/3 Bar	Moisture Holding Capacity 15 Bar	Bulk Density
		Percent	Percent	Percent	Percent by Weight	Percent by Weight	g/cm^3
A1	average	12	70	18	- - -	9.1	- - -
	range	4-20	62-76	16-24	- - -	6.8-12.0	- - -
A2	average	5	70	25	26.6	6.1	1.35
	range	0-14	62-74	18-34	24.1-28.0	4.2-8.2	1.30-1.39
B1	average	7	64	29	23.0	7.2	1.51
	range	0-16	60-74	24-34	22.2-23.8	5.6-8.3	1.45-1.57
B2	average	8	62	30	22.0	7.6	1.60
	range	4-20	58-66	22-36	19.9-23.6	6.6-9.0	1.53-1.71
B'x1	average	10	60	30	20.8	7.7	1.62
	range	6-20	56-66	28-36	18.8-24.3	6.7-9.2	1.51-1.72

WESTERN HIGHLAND RIM PHYSIOGRAPHIC SUBPROVINCE

BAXTER SERIES

Classification: Clayey, mixed, mesic Typic Paleudults

Typical Profile:

A1 -- 0-3" -- Brown (10 YR 4/3) cherty silt loam; weak fine granular structure; very friable; abundant fine, few medium roots; 29 percent chert fragments; very strongly acid; abrupt wavy boundary. (2 to 3 inches thick)

A2 -- 3-10" -- Yellowish brown (10 YR 5/6) cherty silt loam; moderate fine and medium subangular blocky structure; friable; abundant fine and medium roots; 17 percent chert fragments; very strongly acid; gradual smooth boundary. (6 to 7 inches thick)

B1 -- 10-17" -- Yellowish brown (10 YR 5/4) cherty silty clay loam; moderate medium subangular blocky structure; friable; abundant fine, plentiful medium, few coarse roots; 18 percent chert fragments; very strongly acid; abrupt smooth boundary. (5 to 8 inches thick)

B21t -- 17-26" -- Yellowish brown (10 YR 5/6) silty clay loam; few medium distinct red (2.5 YR 5/6) mottles; moderate fine and medium angular blocky structure; friable; plentiful fine and medium, few coarse roots; 14 percent chert fragments; strongly acid; abrupt irregular boundary. (6 to 12 inches thick)

B22t -- 26-35" -- Brownish yellow (10 YR 6/6) cherty silty clay loam; common medium distinct red (2.5 YR 5/6) and few medium distinct very pale brown (10 YR 7/4) mottles; moderate fine and medium angular blocky structure; firm; few fine and medium roots; many thick clay films on ped faces; 19 percent chert fragments; strongly acid; clear wavy boundary. (8 to 10 inches thick)

B23t -- 35-48" -- Red (2.5 YR 5/8) and yellowish brown (10 YR 5/6) very cherty clay; common medium distinct very pale brown (10 YR 7/4) mottles; moderate coarse and very coarse platy breaking to moderate fine and medium angular blocky structure; firm; about 85 percent coarse fragments; strongly acid; clear wavy boundary. (12 to 32 inches thick)

B24t -- 48-61" -- Light gray (10 YR 7/1) to yellowish brown (10 YR 5/8) cherty clay; moderate coarse and very coarse platy structure; very firm; 70 to 85 percent coarse fragments; abrupt wavy boundary. (12 to 15 inches thick)

Table 13.--Chemical and physical properties of 2 profiles* of the Baxter Series

Horizon		Exchangeable				Cation Exchange Capacity
		K	Mg	Ca	Al	
		Meq per 100g				
A1	average	1.10	1.02	3.86	.51	6.78
A2	average	1.00	.34	.79	1.19	3.78
B1	average	.14	.71	.58	2.26	4.16
B21t	average	.15	1.16	.54	2.69	7.48
B22t	average	.17	1.31	.34	7.42	9.63
B23t	average	.13	.87	.21	7.88	9.96

Horizon		Base Saturation	Organic Matter	Total N	Available P	pH
		Percent			ppm	
A1	average	88	5.7	.18	8.00	5.4
A2	average	62	1.5	.07	1.49	5.2
B1	average	30	.6	.04	.87	5.1
B21t	average	25	.4	.04	.18	5.1
B22t	average	19	.3	.03	< .14	5.2
B23t	average	14	.2	.03	< .14	5.1

Horizon		Sand	Silt	Clay	Moisture Holding Capacity		Bulk Density
					1/3 Bar	15 Bar	
		Percent			Percent by Weight		g/cm^3
A1	average	11	72	17	- - -	8.4	- - -
A2	average	7	69	24	29.0	6.1	1.25
B1	average	11	54	35	22.5	9.7	1.50
B21t	average	10	43	47	26.5	15.0	1.50
B22t	average	11	35	55	26.3	18.4	1.51
B23t	average	4	39	57	- - -	7.9	- - -

*Range not meaningful

BODINE SERIES

Classification: Loamy-skeletal, siliceous, thermic Typic Paleudults

Typical Profile:

A1 -- 0-2" -- Dark grayish brown (10 YR 4/2) cherty silt loam; moderate medium granular structure; very friable; abundant fine and medium roots; 30 percent chert fragments; neutral; clear wavy boundary. (1 to 5 inches thick)

A2 -- 2-8" -- Brown (10 YR 5/3) cherty silt loam; moderate medium granular structure; very friable; plentiful fine and medium roots; 19 percent coarse fragments; strongly acid; clear wavy boundary. (3 to 8 inches thick)

B1 -- 8-14" -- Yellowish brown (10 YR 5/4) cherty silt loam; moderate medium subangular blocky structure; very friable; plentiful fine and medium roots; thin patchy clay films on ped faces; 24 percent chert fragments; very strongly acid; clear wavy boundary. (0 to 8 inches thick)

B2t -- 14-25" -- Strong brown (7.5 YR 5/6) and yellowish brown (10 YR 5/4) cherty silt loam; moderate medium and coarse subangular blocky structure; friable; plentiful fine and medium roots; moderately thick patchy clay films on ped faces; 38 percent chert fragments; strongly acid; clear smooth boundary. (5 to 16 inches thick)

B3 -- 25-35" -- Light brown (7.5 YR 6/4) and strong brown (7.5 YR 5/6) cherty silt loam; moderate medium and coarse subangular and angular blocky structure; firm; few fine and medium roots; moderately thick patchy clay films on peds and gravel; 80 percent chert fragments.

Table 14.--Chemical and physical properties of 7 profiles of the Bodine Series

Horizon		Exchangeable K	Exchangeable Mg	Exchangeable Ca	Exchangeable Al	Cation Exchange Capacity
		Meq per 100g				
A1	average	.55	1.63	10.06	.08	12.52
	range	.38-.75	1.10-2.15	4.58-19.84	.04-.19	6.66-22.62
A2	average	.30	.53	2.09	.54	3.70
	range	.11-.50	.15-1.18	.44-5.93	.05-.96	2.22-7.17
B1	average	.14	.46	.84	1.59	3.22
	range	.10-.22	.09-1.11	.30-2.44	.09-2.79	2.17-4.97
B2t	average	.19	1.12	.67	1.75	4.22
	range	.12-.28	.09-2.05	.06-1.60	.42-3.88	2.30-7.05
B3	average	.16	.80	.65	1.31	3.34
	range	.08-.98	.30-1.33	.36-1.16	.10-1.77	2.06-4.88

Horizon		Base Saturation	Organic Matter	Total N	Available P	pH
		Percent			ppm	
A1	average	98	6.9	.25	6.45	6.4
	range	94-100	5.6-9.6	.20-.36	3.15-9.45	5.5-7.3
A2	average	72	2.1	.09	1.60	5.7
	range	34-98	1.2-3.7	.06-.14	1.40-3.85	5.0-7.0
B1	average	43	.7	.04	1.13	5.2
	range	22-97	.3-.9	.03-.06	.42-1.75	4.7-6.7
B2t	average	49	.3	.03	approx. .35	5.0
	range	22-82	.2-.4	.02-.04	<.14-.70	4.6-5.5
B3	average	50	.3	.02	approx. .29	4.8
	range	31-86	.1-.6	.02-.04	<.14-.70	4.6-5.0

Horizon		Sand	Silt	Clay	Moisture Holding Capacity 1/3 Bar	Moisture Holding Capacity 15 Bar	Bulk Density
		Percent			Percent by Weight		[illegible]
A1	average	26	55	19	- - -	16.9	- - -
	range	16-34	46-64	16-22	- - -	13.3-21.3	-
A2	average	16	62	22	30.3	7.6	1.17
	range	6-24	52-74	20-24	28.5-31.8	6.2-8.9	1.13-1.25
B1	average	13	60	27	28.3	6.8	1.22
	range	4-20	54-70	24-32	26.7-29.8	4.2-9.4	1.20-1.24
B2t	average	20	51	29	32.0	8.9	1.22
	range	12-36	40-60	24-40	26.8-40.9	6.7-12.1	1.07-1.38
B3	average	35	42	23	- - -	7.3	- - -
	range	26-56	28-52	16-30	- - -	5.1-9.2	- - -

ENNIS SERIES

Classification: Fine-loamy, siliceous, mesic Fluventic Dystrochrepts

Typical Profile:

A1 -- 0-2" -- Very dark grayish brown (10 YR 3/2) silt loam; weak fine granular structure; friable; abundant fine, plentiful medium roots; 3 percent coarse fragments; strongly acid; clear smooth boundary. (1 to 4 inches thick)

A2 -- 2-10" -- Brown (10 YR 4/3) silt loam; weak fine granular and weak fine subangular blocky structure; friable; plentiful small, medium and large roots; 1 percent coarse fragments; strongly acid; clear smooth boundary. (6 to 12 inches thick)

B21t -- 10-20" -- Yellowish brown (10 YR 5/6) silt loam; moderate medium subangular blocky structure; friable; few fine and medium roots; thin discontinuous clay films; 2 percent coarse fragments; strongly acid; gradual wavy boundary. (9 to 16 inches thick)

B22t -- 20-27" -- Strong brown (7.5 YR 5/6) silty clay loam; moderate medium subangular blocky structure; friable; few fine roots; thin discontinuous clay films; 5 percent coarse fragments; strongly acid; gradual wavy boundary. (6 to 11 inches thick)

B23t -- 27-37" -- Pale brown (10 YR 6/3) silty clay loam; common medium distinct yellowish red (5 YR 5/6) mottles; moderate medium angular and subangular blocky structure; friable; moderately thick continuous clay films; 8 percent coarse fragments; strongly acid; gradual wavy boundary. (7 to 12 inches thick)

B3 -- 37-44" -- Pale brown (10 YR 6/3) clay loam; common medium distinct yellowish brown (10 YR 5/6) and yellowish red (5 YR 5/6) mottles; moderate fine and medium angular blocky structure; firm; few medium roots, thin continuous clay films; 3 percent coarse fragments; strongly acid; gradual wavy boundary. (6 to 8 inches thick)

Table 15.--Chemical and physical properties of 1 profile of the Ennis Series

Horizon	Exchangeable				Cation Exchange Capacity
	K	Mg	Ca	Al	
	Meq per 100g				
A1	.71	.65	2.51	1.08	5.30
A2	.63	.22	.40	1.52	3.11
B21t	.24	1.82	1.28	1.91	5.50
B22t	.29	3.10	1.76	3.09	8.34
B23t	.32	3.35	1.48	4.53	9.95
B3	.32	4.08	1.25	5.15	11.21

Horizon	Base Saturation	Organic Matter	Total N	Available P	pH
	Percent			ppm	
A1	74	6.0	.18	9.10	5.1
A2	42	1.2	.06	1.05	5.1
B21t	61	.4	.04	.70	5.4
B22t	62	.3	.04	<.14	5.4
B23t	52	.2	.04	<.14	5.2
B3	51	.2	.03	<.14	5.2

Horizon	Sand	Silt	Clay	Moisture Holding Capacity		Bulk Density
				1/3 Bar	15 Bar	
	Percent			Percent by Weight		g/cm^3
A1	12	74	14	- - -	8.4	- - -
A2	12	68	20	28.2	5.2	1.20
B21t	8	62	30	24.4	8.8	1.46
B22t	12	54	34	25.6	12.7	1.50
B23t	14	50	36	28.4	13.3	1.48
B3	28	28	44	28.2	13.0	1.48

HUMPHREYS SERIES

Classification: Fine-loamy, siliceous, thermic Humic Hapludults*

Typical Profile:

A1 -- 0-2" -- Very dark grayish brown (10 YR 3/2) cherty silt loam; moderate medium granular structure; very friable; abundant fine and medium roots; 18 percent chert fragments; neutral; clear wavy boundary. (1 to 4 inches thick)

A2 -- 2-8" -- Brown (10 YR 4/3) silt loam; weak medium subangular blocky structure; very friable; abundant fine and medium roots; 15 percent coarse fragments; strongly acid; clear wavy boundary. (1 to 8 inches thick)

B1 -- 8-16" -- Dark yellowish brown (10 YR 4/4) cherty silt loam; common medium distinct brown (10 YR 4/3) stains on ped faces; moderate medium subangular blocky structure; very friable; abundant fine and medium roots; few thin clay films on ped faces; 17 percent chert fragments; very strongly acid; clear wavy boundary. (6 to 12 inches thick)

B21t -- 16-32" -- Brown (7.5 YR 4/4) cherty silt loam; common medium distinct dark brown (10 YR 3/3) stains on ped faces; moderate medium subangular blocky structure; friable; few fine roots; 21 percent chert fragments; very strongly acid; clear wavy boundary. (7 to 18 inches thick)

B22t -- 32" -- Strong brown (7.5 YR 5/6) cherty silt loam; few fine faint pale brown (10 YR 6/3) mottles; common distinct brown (10 YR 4/3) stains on ped faces; moderate medium subangular blocky structure; friable; few fine roots; 43 percent chert fragments; very strongly acid.

* Six out of 8 profiles appear to be high base saturation taxadjuncts to the Humphreys Series.

Table 16.--Chemical and physical properties of 8 profiles of the Humphreys Series

Horizon		Exchangeable K	Exchangeable Mg	Exchangeable Ca	Exchangeable Al	Cation Exchange Capacity
		Meq per 100g				
A1	average	.59	1.88	9.96	.08	12.66
	range	.41-.82	1.65-2.60	3.5-12.75	.04-.16	5.99-19.72
A2	average	.31	.36	1.28	.74	2.95
	range	.15-.43	.13-.55	.44-1.85	.40-1.27	2.25-3.39
B1	average	.20	.79	.82	1.27	3.40
	range	.12-.46	.10-2.02	.25-1.98	.12-2.60	2.25-4.95
B21t	average	.28	1.21	.71	2.00	4.58
	range	.17-.45	.22-2.37	.40-1.24	.09-4.32	2.79-8.11
B22t	average	.17	1.01	.39	2.24	4.19
	range	.13-.23	.35-1.42	.19-.60	1.01-3.44	3.04-5.67

Horizon		Base Saturation	Organic Matter	Total N	Available P	pH
		Percent			ppm	
A1	average	98	7.5	.29	5.24	6.4
	range	97-99	5.9-10.0	.23-.40	4.20 -8.75	6.3-6.9
A2	average	66	1.6	.08	1.65	5.4
	range	33-85	.7-2.4	.06-.10	.70-3.15	4.8-6.7
B1	average	53	.6	.04	.74	5.0
	range	20-89	.2-1.6	.03-.08	.35-1.05	4.7-5.8
B21t	average	50	.2	.03	approx. .30	5.0
	range	26-89	<.1-.4	.02-.04	<.14-.70	4.6-6.4
B22t	average	39	.18	.03	approx. .23	4.9
	range	25-55	<.1-.3	.03	<.14-.70	4.5-5.1

Horizon		Sand	Silt	Clay	Moisture Holding Capacity 1/3 Bar	Moisture Holding Capacity 15 Bar	Bulk Density
		Percent			Percent by Weight		g/cm^3
A1	average	21	61	18	- - -	18.2	- - -
	range	4-34	50-64	16-20	- - -	13.6-24.4	- - -
A2	average	13	64	23	28.1	7.4	1.23
	range	2-20	58-76	20-26	25.9-29.9	6.2-8.8	1.16-1.31
B1	average	13	60	27	26.2	7.8	1.25
	range	8-20	56-68	24-30	22.6-29.0	5.9-8.6	1.16-1.45
B21t	average	15	55	30	26.2	9.0	1.32
	range	6-22	50-60	24-38	25.2-29.8	7.0-11.9	1.18-1.42
B22t	average	19	54	27	- - -	8.3	- - -
	range	14-26	48-58	24-32	- - -	7.0-9.8	- - -

STEMLEY SERIES

Classification: Fine-loamy, siliceous, thermic Typic Fragiudults*

Typical Profile:

A1 -- 0-3" -- Dark grayish brown (10 YR 4/2) silt loam; weak fine granular structure; very friable; abundant fine and medium roots; 7 percent coarse fragments; very strongly acid; clear wavy boundary. (2 to 5 inches thick)

A2 -- 3-7" -- Yellowish brown (10 YR 5/4) cherty silt loam; weak medium granular and fine subangular blocky structure; very friable; abundant fine and medium, plentiful large roots; 21 percent coarse fragments; very strongly acid; clear wavy boundary. (4 to 9 inches thick)

B1 -- 7-12" -- Yellowish brown (10 YR 5/5) cherty silt loam; weak fine subangular blocky structure; friable; plentiful fine, medium and large roots; 26 percent coarse fragments; very strongly acid; clear smooth boundary. (0 to 9 inches thick)

B21t -- 12-19" -- Yellowish brown (10 YR 5/6) cherty silty clay loam; moderate fine and medium subangular blocky structure; friable; plentiful fine and medium roots; many thick clay films on ped faces; 16 percent coarse fragments; very strongly acid; clear wavy boundary. (0 to 11 inches thick)

B22t -- 19-25" -- Strong brown (7.5 YR 5/6) cherty clay loam; common medium distinct yellowish brown (10 YR 5/8) and yellowish red (5 YR 5/8) mottles; moderate medium subangular blocky structure; firm; few fine roots; thin patchy clay films on ped faces; about 30 percent coarse fragments; very strongly acid; abrupt wavy boundary. (0 to 25 inches thick)

IIBx1 -- 25-38" -- Light yellowish brown (10 YR 6/4) to red (2.5 YR 4/6) silty clay loam; moderate coarse prismatic structure; firm; brown (7.5 YR 4/4) thin patchy clay films on ped faces; 5 percent coarse fragments; strongly acid; clear wavy boundary. (5 to 28 inches thick)

IIB2t -- 38-48" -- Red (2.5 YR 4/8) to brownish yellow (10 YR 6/8) sandy clay loam; moderate coarse and very coarse platy structure; firm; abrupt wavy boundary. (0 to 45 inches thick)

* Six of 11 profiles are high base saturation taxadjuncts to the Stemley Series.

Table 17.--Chemical and physical properties of 11 profiles of the Stemley Series

Horizon		Exchangeable K	Exchangeable Mg	Exchangeable Ca	Exchangeable Al	Cation Exchange Capacity
		Meq per 100g				
A1	average	.87	.69	3.24	.90	6.06
	range	.50-1.35	.20-1.51	.64-10.95	.05-1.77	3.82-13.43
A2	average	.75	.24	.60	1.29	3.39
	range	.11-1.42	.05-.50	.12-2.51	.21-2.06	2.55-3.71
B1	average	.19	.52	.43	2.33	3.85
	range	.03-.60	.04-.75	.10-.88	.77-3.26	1.81-5.18
B21t	average	.17	1.22	1.20	2.60	5.57
	range	.06-.28	.19-3.13	.13-3.47	.85-5.05	2.24-8.81
B22t	average	.22	2.39	1.98	2.90	7.83
	range	.09-.33	.51-4.02	.38-4.89	.68-6.00	3.26-11.80
IIBX1	average	.16	1.61	1.57	4.81	7.74
	range	.09-.26	.31-3.43	.14-3.52	1.34-7.62	3.94-10.33
IIB2t	average	.16	2.56	3.46	3.74	9.53
	range	.12-.19	2.04-3.08	2.90-4.03	3.66-3.84	8.02-11.04

Horizon		Base Saturation	Organic Matter	Total N	Available P	pH
		Percent			ppm	
A1	average	74	4.9	.17	6.19	5.3
	range	49-99	3.5-6.8	.12-.27	4.20-9.10	4.6-6.5
A2	average	50	1.3	.08	1.30	5.1
	range	18-92	.8-1.9	.04-.25	.70-3.85	4.9-5.6
B1	average	29	.9	.05	approx. .58	5.1
	range	10-68	.6-1.6	.04-.08	<.14-1.05	4.9-5.3
B21t	average	46	.5	.04	approx. .38	5.2
	range	9-84	.1-.8	.02-.06	<.14-.80	4.5-5.4
B22t	average	59	.4	.04	approx. .10	5.3
	range	21-84	.2-.5	.02-.05	<.14-.80	5.0-5.4
IIBx1	average	39	.3	.03	.18	5.3
	range	9-79	.1-1.4	<.01-.08	<.14-.70	5.0-5.4
IIB2t	average	66	.2	.03	<.14	5.3
	range	65-66	.2	.02-.03	- - -	5.2-5.3

Horizon		Sand	Silt	Clay	Moisture Holding Capacity 1/3 Bar	Moisture Holding Capacity 15 Bar	Bulk Density
		Percent			Percent by Weight		g/cm^3
A1	average	15	69	16	- - -	8.8	- - -
	range	8-22	62-76	14-18	- - -	6.5-17.8	- - -
A2	average	13	65	22	27.1	6.1	1.34
	range	4-28	54-76	18-24	21.7-30.7	4.4-8.4	1.20-1.43
B1	average	9	63	28	24.9	7.4	1.42
	range	4-12	58-72	24-32	21.6-30.7	4.5-9.4	1.19-1.52
B21t	average	12	56	32	24.5	9.9	1.45
	range	6-26	50-64	20-42	20.7-31.5	5.9-12.8	1.28-1.61
B22t	average	16	50	34	26.0	12.4	1.47
	range	8-24	46-56	26-38	21.3-29.0	8.3-17.6	1.38-1.64
IIBx1	average	18	44	38	25.6	12.6	1.54
	range	2-32	26-54	22-58	21.9-31.0	11.3-14.9	1.44-1.64
IIB2t	average	- - -	- - -	- - -	- - -	- - -	- - -
	range	- - -	- - -	- - -	- - -	- - -	- - -

Table 18.--Quantity per acre of various components in the upper 36 inches of the profile

Soil Series	Potential Available Moisture	Organic Matter	Total N	Available P	Exchangeable K	Exchangeable Mg	Exchangeable Ca	Exchangeable Al
	Inches	Pounds						
Cumberland Plateau:								
Clifty	9.5	268,000	11,700	17	1,600	280	870	3,200
Ealy	4.7	169,000	9,700	26	900	200	1,240	1,000
Gilpin	7.3	107,000	6,500	7	1,300	290	880	4,100
Hartsells	6.1	148,000	5,900	14	1,100	360	730	2,700
Linker	3.5	191,000	6,500	16	1,400	280	540	2,200
Lonewood	6.8	175,000	7,300	15	1,100	370	1,050	3,000
Lonewood, Red V.	6.4	232,000	6,200	14	1,500	670	880	4,000
Tilsit	5.8*	125,000	5,700	5	1,700	350	1,160	4,300
Eastern Highland Rim:								
Dewey	6.8	105,000	4,800	9	1,700	850	1,200	4,700
Dickson	5.2*	90,000	4,500	8	1,200	470	840	3,800
Mountview	7.8	116,000	6,200	14	1,600	560	1,010	3,600
Taft	5.3*	69,000	3,500	7	1,200	320	360	3,800
Western Highland Rim:								
Baxter	7.4	127,000	6,600	14	1,900	1,360	1,950	3,700
Bodine	7.1	124,000	6,100	12	1,000	1,230	3,480	1,400
Ennis	9.0	101,000	6,300	11	1,800	2,980	3,110	2,900
Humphreys	9.4	113,000	6,600	11	1,300	1,460	3,140	1,700
Stemley	5.5*	112,000	6,400	11	1,400	1,850	3,460	3,200

*Based on 24" to fragipan. It is assumed that roots do not penetrate the fragipan and that the water therein contained is not available.

Francis, J. K. and Nelson S. Loftus.

1977. Chemical and physical properties of Cumberland Plateau and Highland Rim forest soils. U.S. Dep. Agric. For. Serv. Res. Pap. SO-138, 44 p. South. For. Exp. Stn., New Orleans, La.

Soil descriptions and chemical and physical data for a number of soils of the Cumberland Plateau, eastern Highland Rim, and western Highland Rim areas of Tennessee are presented.

Additional keywords: soil profiles, soil series.

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Site Index Predictions for Red Oaks and White Oak in the Boston Mountains of Arkansas

D. L. GRANEY

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Summary

Predictive equations based on the relationship of soil and topography to site indices of northern red (*Quercus rubra* L.), black (*Q. velutina* Lam.) and white (*Q. alba* L.) oaks in the Boston Mountains indicate that white oaks should be favored for management on the finer-textured soils and on good south and west slope sites. Both red oaks and white oak could be managed on north- and east-facing sites. Neither species group, however, is recommended for the loamy sandstone soils of the region.

Site index of the red oaks species and white oak was correlated with slope shape-position, aspect, slope gradient, surface soil thickness, subsoil texture, and soil group. White oak site index was correlated with slope shape-position, aspect, slope gradient, surface soil texture, and soil group. Separate prediction equations derived for all soils combined and for colluvial plus shale soils accounted for 77 to 79 percent of the variation in red oak site index and 75 to 77 percent of the variation in white oak site index. When tested on independent sets of data, the red oak equations reliably predicted within 5 to 6 feet of measured site index values; white oak equations produced reliable predictions within 3 to 4 feet of measured site index.

Acknowledgement

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1977

Site Index Predictions for Red Oaks and White Oak in the Boston Mountains of Arkansas

D. L. GRANEY

To evaluate investments in silvicultural treatments and to recommend species for management on a given site, land managers in the Boston Mountains need estimates of site productivity for a variety of tree species. A previous study by Graney and Ferguson (1971) produced reliable prediction models relating the site index of shortleaf pine (*Pinus echinata* Mill.) to soil and topographic factors on the major upland soils in the area. Despite problems well summarized by Broadfoot (1969), the soil-site index approach appears to be the most promising one for estimating site potential in areas like the Boston Mountains. This paper reports the relationship of soil and topography to the site indices of northern red (*Quercus rubra* L.), black (*Q. velutina* Lam.), and white (*Q. alba* L.) oaks on major upland soils of the region.

Procedures

Study Area

The Boston Mountains (fig. 1) are the highest, southernmost member of the Ozark Plateaus physiographic province (Fenneman 1938). They form a band 30 to 40 miles wide and 200 miles long extending from central Arkansas westward to east-central Oklahoma.

Elevations range from 1900 to 2500 feet. The plateau is sharply dissected, and most ridges and spurs are generally less than one-half mile wide. Rocks in the area are sedimentary and predominately of Pennsylvanian age; they consist of alternate horizontal beds of shales and resistant sandstones.

Annual precipitation averages 46 to 48 inches in the portion within Arkansas, an area of 2.2 million acres. March, April, and May are the wettest months. Extended summer dry periods are common, and autumn is usually dry. The frost-free period is normally from 180 to 200 days long. The topography was formed by erosion of an uplifted peneplain surface. The tops are flat to gently rolling, and the sides consist of an alternating series of steep simple slopes and gently sloping benches.

Soils common to ridge and upper slope positions are predominantly medium-textured and derived from sandstone residuum (Hartsells, Linker and Mountainburg series); soils common to side slopes are fine-textured and derived from shale residuum (Enders series), and those common to bench positions are typically deep, well-drained, medium-textured soils derived from sandstone and shale colluvium (Nella and Leesburg series).

Field Measurements

Data were collected for 147 red oak plots (northern red oak and black oak) and 138 white oak plots established to represent a range of site conditions common to each species group within the study area. Because height growth patterns and site indices for northern red oak and black oak were similar on all sites and soils, data for each species were combined; they are hereafter referred to as the red oaks.

Study plots were confined to even-aged 40- to 80-year-old stands that were fully stocked and showed no signs of previous heavy cutting or se-

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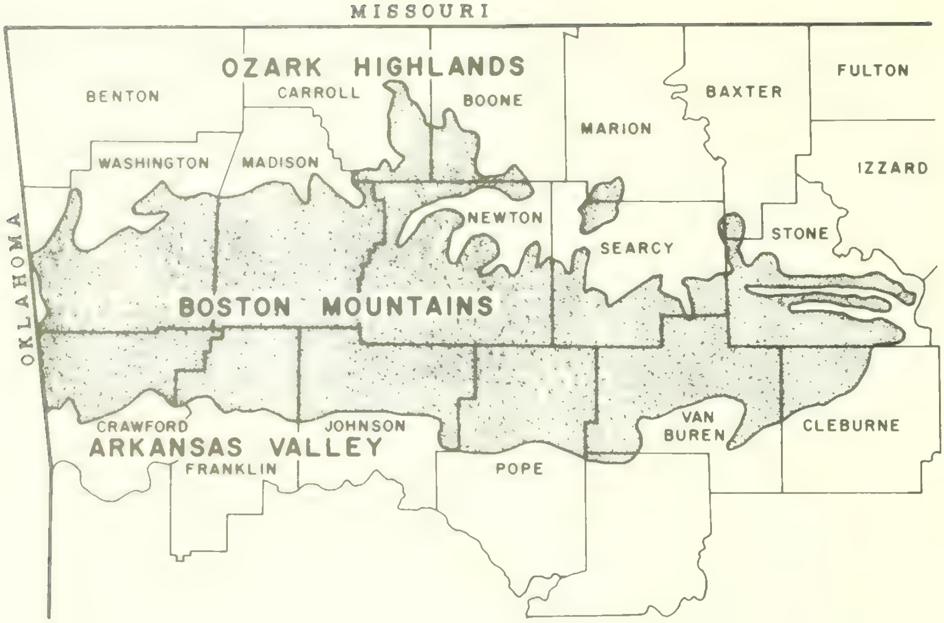

Figure 1.—*The Boston Mountains in Arkansas.*

vere damage from ice or fire. Sample plots varied from one-tenth to one-fifth acre and consisted of three or more dominant or codominant trees grouped as closely as possible to insure uniform soil and topographic conditions.

Tree height and age were obtained from about five (minimum of three) sample trees per plot. On about half of the plots two trees were felled and sectioned at 4 feet intervals to obtain stem analysis data. Site index determinations for these trees were obtained from graphs of height over age. Site index estimates for the remaining trees were obtained by comparing total height and age[1] with locally derived height growth curves (Graney and Bower 1971). Site index for each plot was then determined by averaging the values obtained for individual sample trees.

On each plot, three soil pits were dug to bedrock or to a minimum depth of 60 inches. One pit was located at the center of the plot; the others were near the limits of occupancy of the sample trees. No more than one plot was located in an individual stand unless the stand extended over more than one set of soil or topographic conditions.

All soil profiles were described and classified by Soil Conservation Service soil scientists. Approximately 1 quart of rock-free soil was collected from each major horizon of each soil pit. Also noted were such soil variables as stone content, depth and thickness of the horizons, depth of maximum root penetration, and total soil depth.

Topographic variables determined for each plot were elevation, aspect, slope shape and position, steepness and length, distance from top of slope, township, and range.

Laboratory Measurements

The bulk soil samples were air-dried, rolled, and sieved through a 2-mm-mesh screen. Corresponding horizon samples for the three soil pits in each plot were composited for analyses of pH, particle size distribution, and moisture contents at 1/3 and 15 atmospheres of tension.

Data Analysis

One-fifth of the sample plots for each species-soil group combination were randomly selected and excluded from the original analyses to provide a population on which to test the effectiveness of the derived equations.

Site index was consistently higher for the red oaks than for white oak (fig. 2). Similar site index differences between white oak and various red oak species have been reported for other areas (Doolittle 1958, Olson and Della-Bianca 1959, Hannah 1968b, Watt and Newhouse 1973). Site index for the red oaks was highest on colluvial soils and poorest on sandstone soils; site index for white oak was highest on colluvial and shale soils and lowest on sandstone. Therefore, separate analyses were completed for each species group; two equations were derived for each group—a general equation to predict site index for all soils and a separate equation developed specifically for the productive colluvial plus shale soils.

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[1] Total age was defined as the age determined from increment cores at breast height plus 2 years for the red oaks and 3 years for white oak. The number of years to be added for each species was determined from tree section data.

Of the 147 red oak plots, 118 were used to derive the all-soils equation and 29 served as test plots. The colluvial plus shale soils equation was based on 92 plots and tested on 23 plots. White oak all-soils equations were derived for 112 analysis plots and tested on 26 additional plots. Eighty-eight plots were used to generate the colluvial plus shale soils equations and were tested using 21 plots.

Initially, 35 original soil and topographic site variables plus a series of transformations and two-variable interactions were screened for possible correlations with site index by using the FSCREEN Regression Program described by Frayer and others (1971). The most promising variable from each species-soil group screening were used to derive the regression equations relating oak site index to the selected variables. The reliability of each prediction equation was determined by comparing the predicted site index data to the data actually measured. The accuracy of each equation was determined by calculating the error of prediction at both the 0.05 and 0.10 probability levels with a modification of Freese's (1960) accuracy test. In the present analysis,

$$E \quad \sqrt{\frac{\sum_{i=1}^{n} (x_i - U_i)^2}{\chi^2}} \quad (T)$$

where: E = error of prediction (calculated deviation from the measured value)

χ^2 = the tabular χ^2 value for the selected probability level and n df.

T = the standard normal deviate value at the selected level of probability (0.05 or 0.10).

Results

After original equations were derived for each species and for soil groups, final equations were derived from the entire data sets representing

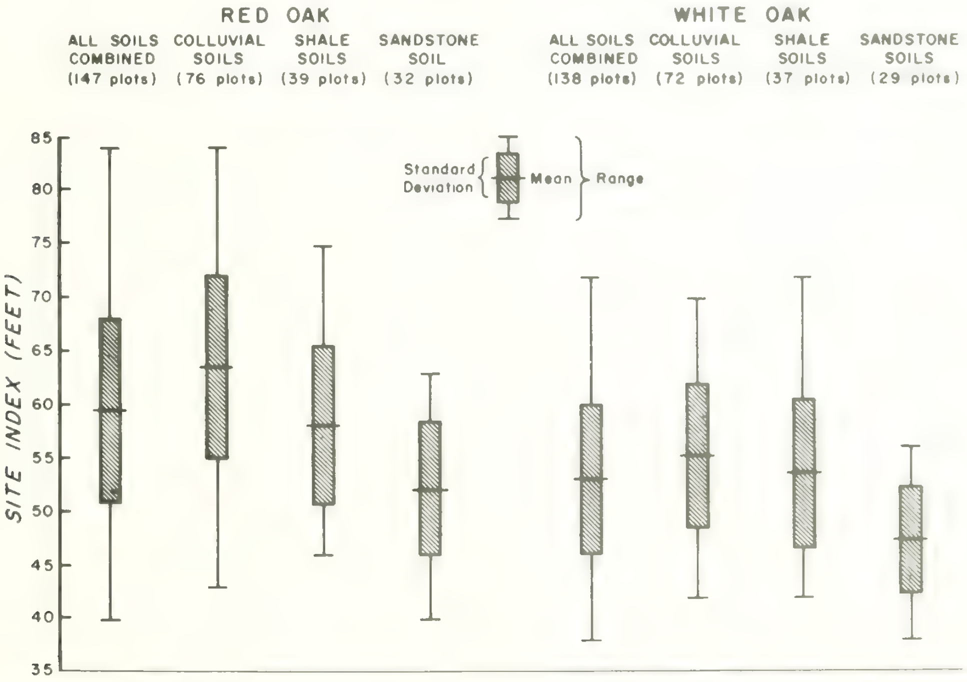

Figure 2.—*Site index mean, range, and standard deviation for red oak and white oak on major soil groups of the Boston Mountains of Arkansas.*

Table 1.—*Coefficient values of the original and final regression equations for predicting red oak and white oak site index (Y) based on soil and topographic variables for the all-soils and colluvial plus shale soil groups.*

Independent variable[1]	Red Oak Equations				White Oak Equations			
	All-soils		Colluv. + shale soils		All-soils		Colluv. + shale soils	
	Original model (118 plots)	Final model (147 plots)	Original model (92 plots)	Final model (115 plots)	Original model (112 plots)	Final model (138 plots)	Original model (88 plots)	Final model (109 plots)
Intercept (b_0)	76.178	76.911	67.421	66.126	49.790	47.959	37.560	37.396
Aspect	2.348	2.393	2.752	2.894	1.732	1.698	1.980	1.990
Slope shape-position	3.503	3.569	3.799	3 867	3.267	3.246	3.365	3.352
Surface soil clay	—	—	—	—	0.370	0.414	0.368	0.382
Subsoil texture	—	—	−0.089	0.083	—	—	—	—
1/Slope gradient	−12.997	−11.454	−7.847	−6.873	9.316	9.694	6.479	−7.331
1/Surface soil depth	−120.821	−117.895	−97.469	−93.007	—	—	—	—
1/Soil group	−12.560	−14.224	—	—	13.422	12.327	—	—
R^2	0.79	0.79	0.77	0.77	0.75	0.77	0.73	0.75
Standard error (± feet)	4.29	4.20	4.27	4.17	3.58	3.36	3.62	3.38

[1] Description of independent variables:

Aspect = Cosine of azimuth from northeast
Slope shape-position = coded 1-5 where 1 = flat ridge tops and narrow spur ridge top positions
2 = convex slopes
3 = linear slopes
4 = concave side slopes and mid-bench positions
5 = inner-bench positions
Surface soil clay = percent clay $A_1 + A_2$ horizons
Subsoil texture = percent silt + clay B_2 horizon
Slope gradient = slope gradient (percent)
Surface soil depth = thickness of $A_1 + A_2$ horizons (inches)
Soil group = coded separately for each species as: $\frac{\text{(mean site index of soil group)}}{\text{(mean site index of sandstone soils)}}$

each species-soil group combination (table 1). All original equations explained 73 to 79 percent of the variation in red or white oak site index; the standard error of estimate was 4.3 feet or less for each red oak equation and 3.6 feet or less for each white oak equation. Site index predictions with each of the equations were reasonably accurate when tested against the independent set of test plot data (table 2).

Ninety percent of the red oak all-soils test plot predictions fell within 5 feet of measured site index, 96 percent fell within 6 feet, and only one prediction missed the measured value by more than 6 feet. Calculated error at the 0.05 level was ± 5.7 feet; the error at the 0.10 level was ± 5 feet. Thus, the equation reliably predicts within approximately 5 to 6 feet of the measured site index.

Site-index predictions by the red oak colluvial plus shale soils equation were slightly more erratic than those from the all-soils equation, but about 83 percent fell within 5 feet of measured values and all predictions were within 6 feet of test plot site index. Assuming a 1 in 20 chance of error, the colluvial plus shale soils equation will predict within about 6 feet of measured site index and within about 5 feet of measured values nine of ten times (table 2).

Although predictions for white oak appeared more accurate than those for red oak (table 2), there was also less variation in white oak site index than was observed for the red oaks. For the all-soils equation, all predictions fell within 5 feet of measured test plot site index; more than 85 percent of the predictions were within 3 feet of measured values. The calculated error of predictions was 3.8 feet at the 0.05 probability level and 3.4 feet at the 0.10 level.

The white oak colluvial plus shale soils equation also produced reliable predictions of test plot site index. As with the all-soils equation, all predictions fell within 5 feet, and more than 85 percent of the predictions were within 3 feet of measured site index. The equation will predict within 3.4 and 3 feet of measured site index values at the 0.05 and 0.10 probability levels, respectively.

Although shown to produce reasonably accurate site index predictions, the original red and white oak equations were derived from only a portion of the available data. The best estimates of the regression coefficients for each equation should be based upon the entire available data set. Consequently, to obtain the best estimates we completed one additional fitting of the data

Table 2.—*Accuracy of red oak and white oak site index prediction equations on test plots.*

Soil group equation	Original Analysis				Test Plots								
	Number of plots	SI mean and SD	R^2	Standard error	Number of plots	SI mean and SD	Calculated error E(.05)	Calculated error E(.10)	Accuracy of predictions				
									R^2	Within 5 ft	Within 6 ft	Absolute mean deviation	Maximum deviation
		ft	%	ft		ft	ft	ft	%	%	%	ft	ft
RED OAK													
All soils	118	60 ± 9	79	± 4.3	29	59 ± 8	± 5.7	± 5.0	81	90	96	2.9	7
Colluvial + shale soils	92	62 ± 9	78	± 4.3	23	61 ± 8	± 5.9	± 5.2	75	83	100	3.2	6
WHITE OAK													
All soils	112	53 ± 7	75	± 3.6	26	53 ± 7	± 3.8	± 3.4	86	100	—	2.0	5
Colluvial + shale soils	88	55 ± 7	73	± 3.4	21	54 ± 6	± 3.4	± 3.0	86	100		1.8	5

(analysis plus test plots) for each species-soil group combination. Final coefficients in each equation changed only slightly from the original estimates; R^2 values were the same for both original and final red oak equations (table 1). For both species, standard error of estimate was lower in each final equation.

The final colluvial plus shale soil equation for each species was used to calculate trend graphs (figs. 3 and 4) that show relationships between site index and various soil and topographic site variables. For each variable shown, a range of values was inserted into the equation while the other variables were kept constant at their mean values.

Discussion

The final equations not only predict site index accurately but also reveal much about the importance of individual soil and topographic factors in the growth of red and white oaks in the Boston Mountains.

Slope Shape-Position

In this study, slope shape referred to a slope's position or location as well as to its concave, linear, or convex shape. Slope shape was the most influential variable in all equations for each species (figs. 3 and 4). In each equation about 60 percent of the total variation in site index was associated with this combined topographic variable. Similar correlations between slope shape and site index have also been reported for shortleaf pine in Arkansas and Missouri (Graney and Ferguson 1971, 1972), white oak in Indiana (Hannah 1968a) and for black oak in Ohio (Carmean 1967). Bowersox and Ward (1972) have also reported a significant relationship between upland oak site index and a combined slope shape-position variable in the Ridge and Valley region of Pennsylvania.

Differences in soil water availability probably contributed most heavily to observed variations in site index. The sites (Fig. 5) (poorest to best) were (#1) the relatively flat mountain tops and narrow spur ridges, where soils are usually loamy, shallow to medium in depth, and of poor water-holding capacity; (#2) the convex side slope positions typified by upper slopes and outer portions of mountain benches, which normally experience a rapid loss of surface and subsurface water; (#3) simple linear slopes—neither convex or concave; (#4) concave side slopes and all mountain bench positions not included in (#2) and (#5), both of which receive water supplements from upper slope positions and are normally characterized by deep, medium-textured soils with high water storage capacities; and (#5) inner portions of mountain benches located at the base of steep interbench slopes. The inner-bench positions are strongly concave and are also characterized by very deep medium-textured soils.

Horizontal bedding of rock layers also contributes to the superiority of inner-bench conditions. Subsurface water tends to flow down slope along

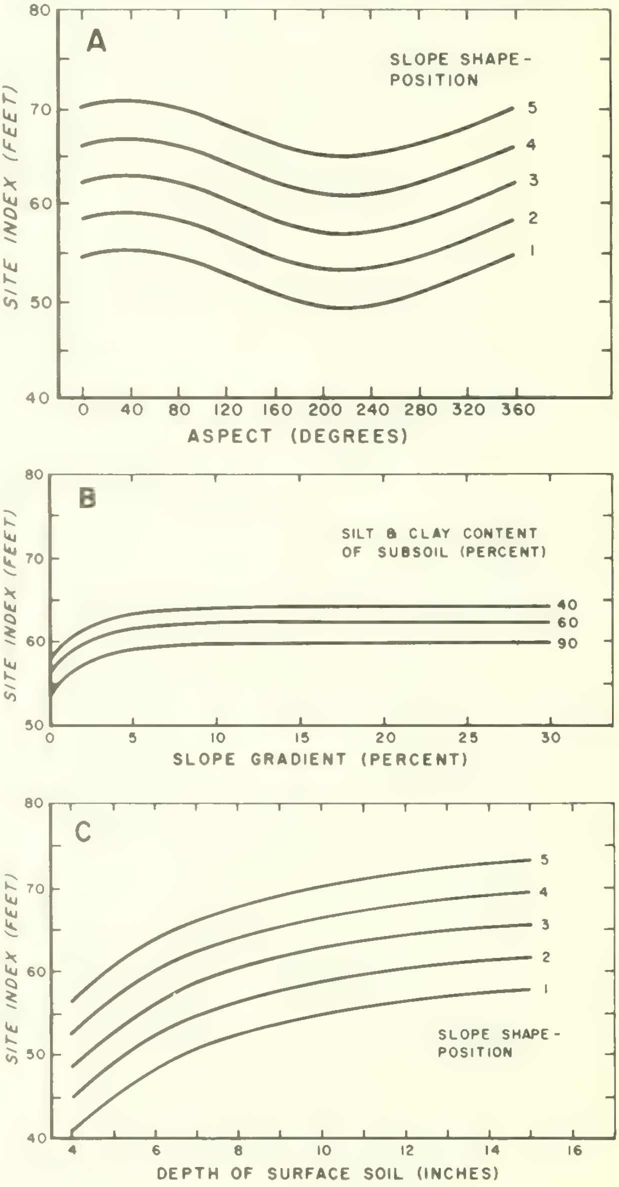

Figure 3.—*Relationship between red oak site index and (A) aspect and slope shape-position, (B) slope gradient and silt plus clay content of subsoil and (C) depth of surface soil and slope shape-position.*

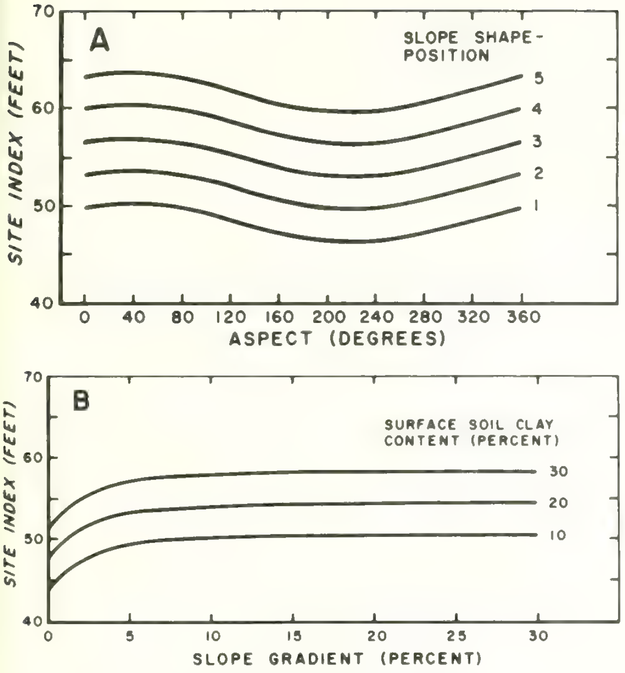

Figure 4.—*Relationship between white oak site index and (A) aspect and slope-shape position and (B) slope gradient and surface soil clay content.*

the bedrock surface and accumulate at the base of the slope. Such positions would also tend to receive subsurface water for relatively long periods. On wider benches (2 to 4 chains), site index decreases rapidly from the inner one-third to the outer edge of the bench, and could vary by as much as 15 feet. Since deep, colluvial accumulations on bench sites are resting on resistant sandstone layers, soil water could pass through the inner-bench soils to depths beyond effective rooting depths of trees on middle and outer bench positions, then follow rock formations horizontally and occur as "seeps" at another inner-bench position further down slope.

Aspect and Slope Gradient

Aspect has contributed significantly to upland oak site quality in several studies. Northeast-facing slopes are usually associated with good oak site quality and southwest-facing slopes with poor sites. The greater net radiation associated with southwest-facing slopes apparently produces higher temperatures, greater rates of evapotranspiration, and more rapid use of total available soil moisture during the growing season than occur on cool northeast-facing slopes (Carmean 1965, 1967). In areas with high summer rainfall, moisture stresses due to temperature may influence growth more than does soil moisture regime. In the mountains of West Virginia, Lee and Sypolt (1974) observed that on south-facing slopes lower midday soil temperatures limit absorption of available water while higher canopy temperatures increase the transpiration demand. Vegetation on south-facing slopes might be subjected to daily stresses more severe and of greater duration than those occurring on north-facing slopes; therefore levels of assimilation would be lower on south-facing slopes. Soils on northeast aspects are often deeper and have more organic matter and soil nutrients than comparable soils on southwest-facing slopes. In this study, red oaks were more sensitive to changes in aspect than white oak (figs. 3 and 4). Maximum site index differences between northeast and southwest slopes were about 5 to 6 feet for the red oak species and about 3 to 4 feet for white oak. White oak is often the dominant species on south and west slopes in the study area.

Site index for each species also increased with increasing slope steepness. The effect of slope gradient was most pronounced for slopes ranging from nearly level to about 10 percent, while slopes of more than 10 percent had little influence on site quality. Although slope gradient might indicate differences in soils (the loamy group commonly occurs on nearly level to gently rolling positions), it probably indicates the effect of rapid drainage of the fine-textured Enders soil on sloping sites. On relatively level sites the Enders soils, which have clayey subsoils, tend to drain slowly, and aeration problems might occur during wet spring months.

Depth of Surface Soil

Red oak site index was strongly correlated with surface soil depth (A1 + A2 horizons). Site in-

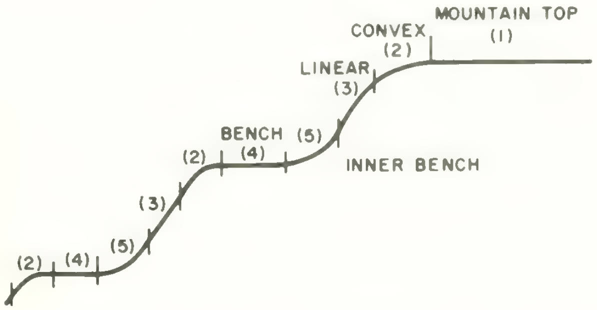

Figure 5.—*Slope shape-position classification for typical topographic features of the Boston Mountains; (1) flat ridge tops and narrow spur ridgetop positions, (2) convex slopes, (3) linear slopes, (4) concave side slopes and mid-bench positions, (5) inner-bench positions.*

dex increased rapidly with increasing A horizon thickness up to about 8 inches, then increased more slowly as the horizon became thicker (fig. 3). Coile (1952) has pointed out that soil depth and thickness of the horizons near the surface reflect the quality and quantity of the root environment. Because Boston Mountain surface soils are typically porous, have a granular structure, and contain moderate amounts of organic matter and nutrients, they should provide a favorable environment for root growth and development. When the A horizon is thick, the soil volume is favorable for root growth and ultimately for tree growth. In this study thick A horizons were often associated with the deep colluvial soils occurring on the lower slope positions. Therefore, the surface soil depth variable could be associated with differences in soil group productivities (fig. 2).

Although surface soil thicknesses were about the same for red and white oak plots, correlations between this variable and white oak site index were weak. Evidently, white oak is less sensitive to the quality of the root environment than red oak and will grow well over a wide range of soil depths and textures.

Surface Soil Clay and Subsoil Texture

White oak site index increased linearly with increasing clay content of the A horizons (fig. 4). Ike and Huppuch (1968) have reported high white oak site quality associated with finer-textured surface soils in the mountains of Georgia. In the Boston Mountains, low surface soil clay contents are generally associated with sandy residual soils, while moderate to high clay contents are usually found in colluvial and shale soils, which were about equal in average white oak productivity.

For red oaks, subsoil textures were correlated with site index only for the colluvial plus shale soils group. Red oak site quality decreased as silt plus clay contents increased (fig. 3), an indication of the superiority of medium-textured colluvial soils. The decreases in red oak site index when silt plus clay content increases show that red oaks are more sensitive to quality and quantity of the root environment than white oak. Roots tend to penetrate more deeply into soils with medium-textured subsoils than into those with predominantly clay subsoils, which have slow internal drainage in the wet spring months and resist root penetration in the dry summer months.

Conclusion

White oak should be favored for management on finer-textured soils and on the better south and west slope sites, while both red oaks and white oak could be managed on north- and east-facing sites. Though white oak site index (base age 50) is commonly lower than red oak on better sites, it maintains a fairly rapid rate of height growth up to and beyond age 80, while red oak height growth declines rapidly after about age 60 (Graney and Bower 1971). Thus, at a rotation age of 80 to 100 years on medium to good sites, white oak could attain about the same or greater height as red oak.

Neither oak species group is recommended for management on the loamy, sandstone soils. Not only is oak productivity low for these soils, but tree form and log quality are also poor. A previous site index study in the Boston Mountains (Graney and Ferguson 1971) has shown that shortleaf pine productivity is relatively high for loamy soils. On these soils, shortleaf pine is recommended for management.

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The relationship of soil and topography to site indices of northern red (*Quercus rubra* L.), black (*Q. velutina* Lam.) and white (*Q. alba* L.) oaks in the Boston Mountains indicates that white oaks should be favored for management on the finer-textured soils and on good south and west slope sites. Both red oaks and white oak could be managed on north- and east-facing sites. Neither species group, however, is recommended for the loamy sandstone soils of the region.

Additional keywords: *Quercus rubra* L., *Q. velutina* Lam., *Q. alba* L., aspect, slope shape, slope gradient.

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arvesting Costs r Mechanized Thinning Systems Slash Pine Plantations

AMES E. GRANSKOG

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Summary

Harvesting costs of four tree harvester systems were estimated for row thinning 15-year-old slash pine plantations. Two full-tree harvester systems had lower harvesting costs per cord than shortwood harvester and tree-length harvester systems. The shortwood and tree-length harvester systems had lower manpower requirements, but their high capital cost in relation to output resulted in higher harvesting costs when compared to the full-tree harvester systems.

1978

Harvesting Costs for Mechanized Thinning Systems in Slash Pine Plantations

JAMES E. GRANSKOG

The vast southern pine plantation acreage now in need of its first commercial thinning has spurred the development of specialized tree harvesting machines. Currently, tree harvesters are mainly used on company operations of pulp and paper firms owning large acreages of plantations. However, independent contractors, who do most of the timber harvesting in the South, must also adopt such machines if thinning requirements are to be met. Furthermore, many contractors are located in areas where plantations are concentrated and will likely be the most commonly available stumpage.

Production and cost information are needed for selecting the most suitable machines for specialized thinning operations. This report estimates harvesting costs for four tree harvester systems designed to row thin slash pine plantations. These estimates can be used to compare systems or to determine economical thinning opportunities for a given system.

Systems and Procedures

Tree harvesters may be classified into three general types according to the form of their output—shortwood, tree-length, and full-tree. That is, the output from the machines will be a bunch of bolts (shortwood), bunched tree-length logs (tree-length), or bunched trees (full-tree). Because the functions performed by each type of harvester are different, measures of output and cost are not directly comparable among the machines. However, the harvesters can be compared by considering them as a part of systems that carry wood to a common delivery point. Evaluation of the systems takes into account the supporting equipment and labor needed with each type of harvester. Evaluating the harvesters on a systems basis also makes possible comparisons of proposed harvesting systems with existing ones.

The following thinning systems were selected to permit estimates of investment, harvesting cost, and productivity:

A) shortwood havester/forwarding/shortwood hauling
B) tree-length harvester/grapple skidding/tree-length hauling
C) full-tree harvester/chain saw limbing and topping/grapple skidding/tree-length hauling
D) full-tree harvester/chain saw limbing and bucking/forwarding/shortwood hauling.

These options are typical combinations with each of the harvesters. Two options for processing and handling wood with the full-tree harvester were selected, since further processing of bunched trees is required with this machine.

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The procedures used for determining system requirements and estimating harvesting costs were the same for all systems. Output rates of the harvesters were obtained for row thinning slash pine plantations and were adjusted to reflect the same performance criteria. Harvester output determined the supporting equipment and men added to complete each system. Assumptions made for skidding and hauling distances and for computing labor and equipment costs were the same for all systems.

System Requirements

Any harvesting system should be designed around the most expensive or key piece of equipment. In a mechanized thinning system, the production of the harvester controls the output rate of the total operation. Therefore, productivity rates of the harvesters can be used to determine the additional equipment and men needed to make-up a system.

Productivity estimates for machines representative of the three types of harvesters being evaluated have been reported for row thinning slash pine plantations (Anderson and Granskog 1974). Table 1 shows hourly production rates, by harvester type, for selected stand conditions in 15-year-old plantations, a common age for thinning. These production figures, however, represent potential output without allowance for downtime or idle time. For this analysis, a 75-percent utilization standard is assumed for each harvester.

To complete each system, supporting equipment and men were selected by determining for each function the number of units required to handle the daily output produced by the harvesters. To insure that harvester output was the limiting factor, the stand condition where production was greatest—site index 70 with 500 trees per acre—was the output level for determining supporting requirements. With the utilization factor applied, these production levels on a daily basis are shortwood, 24.2 cords; tree-length, 35.4 cords;

Table 1.—*Tree harvester productivity for selected stand conditions in 15-year-old slash pine plantations*[1]

Site index	Total trees per acre	Harvester type		
		Shortwood[2]	Tree-length[3]	Full-tree[4]
		Cords per hour		
60	500	3.49	4.73	8.87
	600	3.40	4.19	7.96
	700	3.35	4.04	7.87
	800	3.21	3.67	7.79
70	500	4.04	5.87	9.99
	600	4.01	5.13	8.84
	700	3.90	4.72	8.20
	800	3.75	4.27	8.06

[1] Anderson and Granskog 1974.

[2] 7-foot bolts in approximately 1/3-cord piles.

[3] Bunched tree-length logs, 4-5 trees per bunch.

[4] Bunched trees, 4 trees per bunch.

and full-tree, 59.9 cords. Production rates for skidding, loading, and hauling equipment were then compared with these levels to determine the number of units required.

Total system requirements are summarized in figure 1. Skidding of 660 feet and hauling distances of 30 miles were assumed in all cases. Separate loaders are required in two systems to place tree-length material on hauling units; shortwood is unloaded by the prehaulers directly onto set-out trailers. More trucks are needed to transport tree-length material than shortwood because the short length of plantation stems does not fully utilize trailer capacity. Trucking requirements were based upon 7-cord loads for tree-lengths and 10-cord loads for shortwood.

In the shortwood and tree-length harvester systems, felling and processing are completed by the harvesting machines. The two systems incorporating the full-tree harvester require chain saw operators for processing the bunched trees. It is estimated that two men would be needed to limb and top tree-length logs, and four men would be required for limbing and bucking 7-foot shortwood.

Production manpower requirements for each system, following the letter designations in fig. 1, are: A—3 men, B—4 men, C—8 men, and D—9 men. Tree-length wood is loaded by the truck drivers.

System Costs

Harvesting cost estimates for each system may be computed by calculating hourly system costs and using production rates from table 1 with adjustment for the 75-percent utilization standard assumed.

A synopsis of system costs is contained in table 2. Investment figures are based on prices of new machines in 1977, except it was assumed that tree-length loaders would be mounted on used trucks. Major assumptions for computing machine costs were 5-year depreciation for all equipment (except 1-year depreciation for chain saws), 20 percent salvage value, and 14 percent of the average annual investment for interest, insurance, and taxes. Repair and maintenance charges were 100 percent of the purchase price. Fuel, oil, and lubrication costs were also included. Labor costs were determined by multiplying the number of men required in each system by a $5.50 per hour cost, which included wages and charges for social security, workers' compensation, and unemployment insurance.

Table 2.—*System costs*

System	Initial investment	Hourly costs		
		Machine	Labor	Total
A	$148,700	$37.92	$16.50	$ 54.42
B	198,500	52.39	22.00	74.39
C	203,200	58.64	44.00	102.64
D	173,200	50.13	49.50	99.63

SYSTEM	FUNCTIONAL REQUIREMENTS								
A	1 shortwood harvester	→	1 prehauler	→	1 truck. 3 set-out trailers				
B	1 tree-length harvester	→	1 grapple skidder	→	1 loader	→	2 trucks 2 trailers		
C	1 full-tree harvester	→	2 chain saw operators (limb & top)	→	2 grapple skidders	→	1 loader	→	2 trucks 3 trailers
D	1 full-tree harvester	→	4 chain saw operators (limb & buck)	→	2 prehaulers	→	2 trucks 5 set-out trailers		

Figure 1.—*Systems components*

Table 3.—*Estimated harvesting costs per cord of four tree-harvester systems for selected stand conditions in 15-year-old slash pine plantations*

Site index	Total trees per acre	Harvesting systems			
		A	B	C	D
		Cost per cord			
60	500	$20.77	$20.95	$15.43	$14.98
	600	21.34	23.69	17.19	16.69
	700	21.68	24.55	17.40	16.87
	800	22.58	27.05	17.58	17.06
70	500	17.96	16.91	13.70	13.30
	600	18.08	19.32	15.48	15.03
	700	18.57	21.01	16.69	16.20
	800	19.37	23.25	16.97	16.47

Cost-per-cord estimates (table 3) were obtained by dividing hourly system costs (machine plus labor) by hourly system outputs (harvester production rates adjusted for 75-percent utilization) for the selected stand conditions. Stumpage and administrative expenses are not included in the cost-per-cord estimates. Manpower productivity figures are shown in table 4.

For all systems, productivity decreases and harvesting costs increase as site index drops from 70 to 60 and stand density increases. This is because tree size declines as site index decreases and stand density increases.

Both full-tree harvester systems cost less per cord than the shortwood harvester and tree-length harvester systems, even though the latter two are more advantageous in man-day productivity. Although the shortwood and tree-length machines reduce manpower requirements, the high capital cost in relation to their output compares unfavorably with the full-tree harvester systems. The capability of the full-tree machine to put considerably more wood on the ground and allow processing of bunched stems by chain saw operators results in lower harvesting costs.

Table 4.—*Output per man-day of four tree harvester systems for selected stand conditions in 15 year-old-slash pine plantations*

Site index	Total trees per acre	Harvesting system			
		A	B	C	D
		Cords per man-day			
60	500	7.0	7.1	6.6	5.9
	600	6.8	6.3	6.0	5.3
	700	6.7	6.1	5.9	5.2
	800	6.4	5.5	5.8	5.2
70	500	8.1	8.8	7.5	6.7
	600	8.0	7.7	6.6	5.9
	700	7.8	7.1	6.2	5.5
	800	7.5	6.4	6.0	5.4

Discussion

From the standpoint of harvester selection, the cost per cord estimates presented here indicate a full-tree harvester has an advantage over other types of harvesters for the stand conditions considered, whether it is combined with shortwood or tree-length supporting equipment. When upgrading an existing system, a full-tree machine would be favored to go with either type of supporting equipment that is being used.

Assembling a new system would permit a choice in the type of supporting machines used with the harvester. Although the shortwood option has slightly lower costs among the two alternatives examined, the cost-per-cord estimates for the conditions considered were based on fixed skidding and hauling distances. The effect on total costs as these factors change should be considered in the selection of auxiliary equipment, as well as other factors that may vary between systems.

For example, a prehauler is more cost-effective when long skidding distances are involved because it has a larger capacity than a grapple skidder (typically two cords vs. one cord or less). This offers greater versatility in harvesting small or isolated tracts. Landing costs are minimized with a prehauler system because set-out trailers may be parked along truck roads without construction of a large landing area. A prehauler also can maneuver in a stand with less damage to standing trees than a grapple skidder with a load of tree-length wood.

Alternatively, a grapple skidder with a full-tree harvester may offer more development flexibility. For instance, an iron gate delimber is a simple, cost-effective means of eliminating manual delimbing with a grapple skidder (Bryan 1977). Also, a full-tree harvester/grapple skidder combination can be upgraded into a whole tree chipping operation.

The potential of any harvesting system can be lost by poor planning and administration. A good maintenance program is essential to obtain the machine availability necessary for a successful mechanized operation. Downtime can be minimized by careful planning. For instance, the harvester is the limiting machine in the systems considered. Operating the harvester a few days ahead of the rest of the equipment would help avoid total shutdowns and improve system reliability. The lead time insures a supply of felled wood for other functions when the harvester is idled for repairs.

Adopting a mechanized thinning system, of course, requires a large capital investment. Many independent operators today may not be willing or able to undertake the investment required to perform all of the functions of the harvesting operation. One approach to this problem may be to encourage machine operators who become proficient in a function to purchase their own machines. Truck drivers and harvester and prehauler operators who have the inclination to operate their own businesses could specialize in that capacity for a number of other wood producers.

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Granskog, James E.

1978. Harvesting costs for mechanized thinning systems in slash pine plantations. U.S. Dep. Agric. For. Serv. Res. Pap. SO-141, 7 p.

Harvesting costs of four tree harvester systems are estimated for row thinning slash pine plantations. Systems incorporating a full-tree type harvester had lower harvesting costs per cord than shortwood and tree-length harvester systems in 15-year-old plantations.

Additional keywords: Tree harvesters, mechanization, productivity, and logging costs.

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Summer Fallowing – A Simple Technique For Improving Old-Field Sites For Cottonwood

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Summary

Fallowing old fields during the summer before planting eastern cottonwood significantly increased survival and growth through age 5. Fallowed plots produced 1,700 ft^3 of merchantable wood per acre while untreated controls produced only 540 ft^3—a 215 percent increase. Little benefit was derived from second-year cultivation of fallowed plots, but on plots not fallowed before planting, second-year cultivation increased height and diameter growth by about 30 percent in the second and third years. Deep plowing, cover cropping, or fertilization did not influence growth or survival.

Summer Fallowing—A Simple Technique For Improving Old-Field Sites For Cottonwood

JAMES B. BAKER AND B. G. BLACKMON

Survival and growth of planted eastern cottonwood *(Populus deltoides* Bartr.*)* are often poor on abandoned fields in the Mississippi River floodplain. These fields usually have compacted, nutrient-depleted surface soils and abundant grasses and other herbaceous vegetation. To improve establishment and growth of cottonwood on these sites, intensive soil management appears essential. Earlier, we reported the effects of several soil management treatments on the initial survival and early growth of cottonwood planted on a deteriorated old-field site (Baker and Blackmon 1973). This paper reports the results of these soil treatments and extended cultivation on cottonwood growth and yield on this site through age 5.

Methods

The study area is an abandoned old field on Crown Zellerbach Corporation property in Issaquena County, Mississippi. It had been cropped for about 30 years and pastured for 8 years. Soil is a Commerce silty clay loam (Aeric Fluvaquent).

Soil treatments included:

1. Summer fallowing: Plots disked four times at about 3-week intervals between June and August 1970.
2. Cover cropping: Winter rye and vetch (25 lbs/acre of each) seeded on disked plots in September 1970. The cover crop was incorporated into the soil by disking in January 1971.
3. Deep plowing: Plowing to a 16-inch depth with a moldboard plow in September 1970.
4. Fertilization: Ammonium nitrate at the rate of 200 lbs of N per acre broadcast on the soil surface and incorporated by disking in April 1972.
5. Control: No treatment.

The first three treatments were applied before planting. Fertilizer was applied at the beginning of the second growing season. All plots, including the controls, were uniformly disked before planting.

Treatments were replicated three times in a randomized complete block design. Plots were 36 by 800 feet (0.66 acres) in size. Cottonwood cuttings were planted at 12- by 12-foot spacing in February 1971.

All plots were cultivated at least three times during the first growing season. At the beginning of the second year, treatment plots were split, and one-half of each plot was cultivated at least three times during the second season.

Tree height measurements were made at the end of each year. Diameter (dbh) measurements were

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made at the end of the second through the fifth years. Survival counts were taken following the first and fifth years. Leaf samples were collected in August of the second and third years from randomly selected trees within each plot and analyzed for nitrogen (N), phosphorus (P), and potassium (K) concentrations. After analysis of variance (ANOV), differences in treatment means were evaluated by Duncan's new multiple range test (DNMRT). All statistical tests were performed at the 5 percent level of probability. In addition, fifth-year results were analyzed by a cottonwood growth simulator developed by Crown Zellerbach Corporation.[1] The simulator predicted tree growth and yield over a 12-year rotation.

Results and Discussion

Tree Height and Diameter Growth

Summer fallowing significantly improved height and diameter growth of planted cottonwood through the fifth year (table 1). At age 5, trees on summer-fallowed plots averaged 58 feet in height and 7.8 inches in diameter, compared with 45 feet in height and 6.0 inches in diameter for control trees, a 29 and 30 percent increase as a result of fallowing.

Trees on plots that had been deep plowed, cover cropped, or fertilized, but not fallowed, averaged only 3 feet taller and 0.5 inch larger in diameter than controls at age 5. Blackmon and White (1972) and Blackmon (1977b) tested N fertilization on old-field soils similar to the one in this study and reported significant cottonwood growth response. However, they applied fertilizer at plantation ages 6 to 10, at which time competition among trees for nutrients was critical. Blackmon (1977a), having fertilized cottonwood on an old-field site at plantation ages 2, 3, and 4, measured a growth response only with the final application. He concluded that response to fertilization is not likely to occur in widely spaced plantations until the site becomes fully occupied and competition for nutrients established. The lack of response to fertilization probably resulted from the early (second-year) application of fertilizer.

The major response to fallowing came during the first 3 years (table 1). By age 4, the annual benefits of fallowing had diminished. However, the advantages incurred during the early years remained evident in total tree heights and diameters.

Tree Survival

Summer fallowing also resulted in significantly better survival than did other treatments. At the end of the first year, survival averaged 84 percent on fallowed plots but only 68 percent on unfallowed plots. By the fifth year, 79 percent of the trees on fallowed plots were alive, compared with 59 percent on unfallowed plots.

Volume Production

By the end of the fifth year, average tree volumes ranged from 3.2 ft^3 per tree on controls to 7.3 ft^3 per tree on fallowed plots, a 128 percent difference (table 2). The large increase in average tree volume, coupled with the significantly better survival from fallowing, resulted in even larger differences in total volume yield at age 5. Total yield ranged from 542 ft^3 per acre on controls to about 1,700 ft^3 per acre on fallowed plots, a 215 percent increase (128 percent due to better tree growth and 87 percent due to better survival).

The cottonwood growth simulator predicts that by age 12, trees on the summer-fallowed plots will produce 45 cords of merchantable wood per acre, as compared with only 21 cords per acre for the control plots (fig. 1).

Table 1.—*Effect of soil treatment on annual growth of cottonwood*

Treatment	Growth									
	1st year	2nd year	3rd year		4th year		5th year		Total	
	Ht	Ht	Ht	DBH	Ht	DBH	Ht	DBH	Ht	DBH
	ft	*ft*	*ft*	*in*	*ft*	*in*	*ft*	*in*	*ft*	*in*
Control	5 b[1]	8 b	10 b	1.6 b	11a	1.5a	11a	1.2a	45 b	6.0 b
Cover crop	7 b	9ab	10 b	1.7 b	11a	1.5a	11a	1.3a	48 b	6.6 b
Deep plow	7 b	9ab	10 b	1.8 b	12a	1.6a	11a	1.0a	49 b	6.4 b
Fertilize	6 b	10ab	10 b	1.7 b	12a	1.2a	8a	1.2a	46 b	6.4 b
Summer fallow	10a	12a	14a	2.0a	10a	1.5a	12a	1.1a	58a	7.8a

[1] Means in the same column followed by the same letter are not significantly different (0.05 level).

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[1] Crown Zellerbach Corp., Bogalusa, La. Unpublished data.

Table 2.—*Effect of soil treatment on average cottonwood volume and total yield at age 5*

Treatment	Average tree volume[1]	Trees per acre	Total volume per acre
	ft^3		*ft*^{3}
Control	3.2 b[2]	164 b	542 b
Cover crop	4.4 b	180 b	812 b
Deep plow	3.9 b	193 b	756 b
Fertilize	4.0 b	167 b	672 b
Summer fallow	7.3a	237a	1704a

[1] Merchantable volume outside bark to a 3½ inch top. Calculated from equation by Mohn and Krinard (1971).

[2] Means in the same column followed by the same letter are not significantly different (0.05 level).

Summer fallowing is widely used in agriculture, especially in semiarid regions, both for weed control and for soil moisture conservation. These benefits are also attainable in cottonwood plantations.

On grass-infested old fields having compacted and nutrient-depleted surface soils, summer fallowing can temporarily improve soil structure, allowing for better water infiltration. Fallowing also incorporates organic matter and nutrients into the soil. Finally, by reducing competing vegetation, fallowing allows for maximum storage of soil moisture and eliminates any allelopathic effect that competing vegetation, particularly Johnson grass (*Sorghum halepense* (L.) Pers.), might have on cottonwood growth.

Influence of Second-Year Cultivation on Tree Growth

The major benefit of cultivating established plantations is probably competition control. However, like summer fallowing, it also improves soil structure, water infiltration and storage, organic matter, and availability of nutrients. Second-year cultivation had a significant influence on tree growth during the second and third growing seasons, and growth benefits were still evident in tree heights and diameters at the end of the fifth year (table 3).

Cultivation during the second growing season was most important on plots that had not been fallowed the summer before planting. By the end of the third growing season, trees that had been cultivated the second year but not fallowed averaged 5 feet taller and 0.8 inch larger in diameter than uncultivated and unfallowed trees. Most of this increase occured during the second growing season. In contrast, on plots that had been fallowed, extended cultivation resulted in only 2 feet

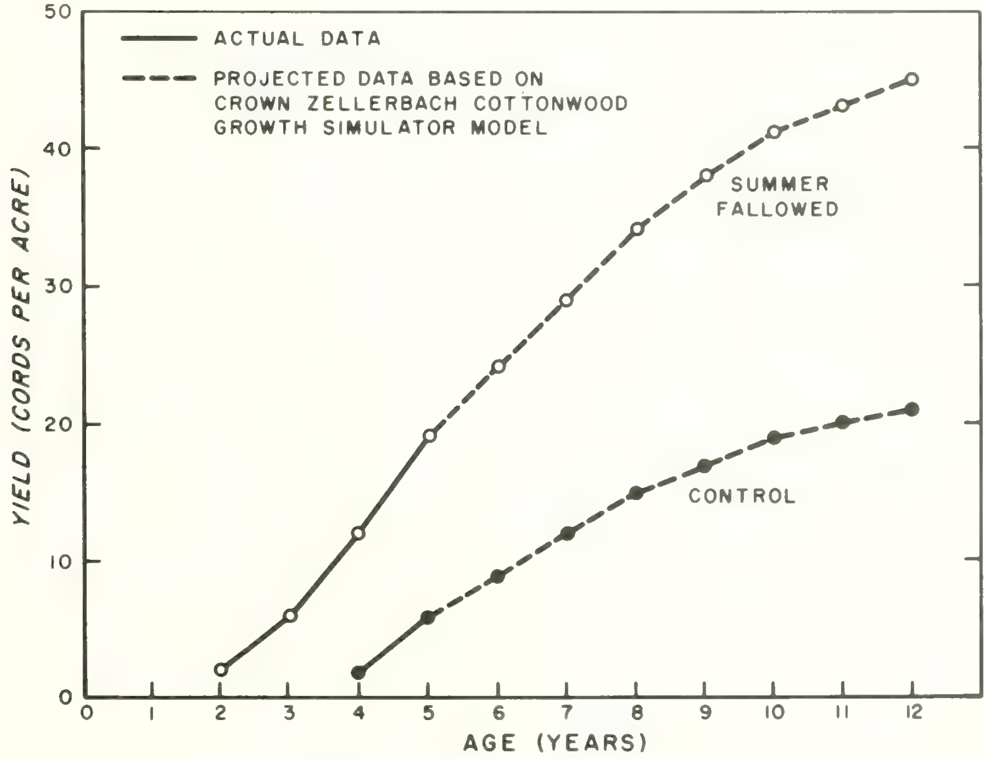

Figure 1.—*Anticipated cottonwood yield over a 12-year rotation.*

Table 3.—*Effects of second-year cultivation on cottonwood growth*

Treatment	Tree growth by year								
	2nd year	3rd year		4th year		5th year		Total at 5 years	
	Ht	Ht	DBH	Ht	DBH	Ht	DBH	Ht	DBH
	ft	*ft*	*in*	*ft*	*in*	*ft*	*in*	*ft*	*in*
No second-year cultivation	8 b[1]	10 b	1.7 b	11a	1.5a	10a	1.2a	48 b	6.4 b
Second-year cultivation	11a	12a	1.9a	11a	1.3a	11a	1.1a	52a	6.9a

[1] Means in a column followed by the same letter are not significantly different (0.05 level).

more height growth and 0.3 inch more diameter growth by the third year. Since there was relatively little herbaceous vegetation on the fallowed plots at the beginning of the second season, little was gained by additional competition control. Besides promoting significantly better growth and survival throughout the first 3 years of plantation establishment, summer fallowing also appears to eliminate the need for second-year cultivation.

Influence of Treatments on Foliar Nutrient Levels

All treatments significantly increased foliar N concentrations during the second year (table 4). Second-year foliar N levels ranged from 1.96 percent for controls to 2.43 percent for summer-fallowed plots. Treatments had no effect on P and K levels during the second or third years, nor did they influence third-year N levels.

Second-year cultivation also affected foliar N levels during the second and third years. Nitrogen concentrations in the second year averaged 2.06 percent for trees on uncultivated plots and 2.51 percent for trees on cultivated plots. The following year, N concentrations on the uncultivated plots were 2.04 percent; concentrations on cultivated plots were still significantly elevated to 2.31 percent.

Cultivation increased N levels in cottonwood foliage almost as much as an application of 200 lbs per acre of N fertilizer. When fertilizer N was applied to plots which had not been cultivated in the second year, foliar N concentrations averaged 1.97 percent. When the fertilizer was applied to plots which had received second-year cultivation, foliar N levels averaged 2.75 percent. By the third year, trees that were fertilized, or cultivated, or both, averaged about 2.34 percent foliar N. The high foliar N levels associated with cultivation probably resulted from periodic incorporation of green herbaceous matter (accompanied by its release of N during decomposition) and reduction of competition for the available soil N.

Table 4.—*Effect of treatment on second- and third-year foliar nutrient levels*

Treatment	Foliar nutrient concentration by years	
	2nd year N	3rd year N
	Percent	
Control		
No cultivation	1.64	2.01
Cultivation	2.29	2.27
Mean	1.96 b[1]	2.14a
Summer fallow		
No cultivation	2.34	2.11
Cultivation	2.52	2.43
Mean	2.43a	2.27a
Fertilization		
No cultivation	1.97	1.92
Cultivation	2.75	2.36
Mean	2.36a	2.14a
Cover cropping		
No cultivation	2.17	2.05
Cultivation	2.45	2.10
Mean	2.31a	2.08a
Deep Plowing		
No cultivation	2.17	2.10
Cultivation	2.54	2.41
Mean	2.36a	2.26a
Mean		
No cultivation	2.06	2.04
Cultivation	2.51[2]	2.31[2]

[1] Means in the same column for each treatment followed by the same letter are not significantly different (0.05 level).

[2] Indicates a significant difference (0.05 level) between 2nd-year and no 2nd-year cultivation (averaged over treatments).

Conclusions

Summer fallowing (disking as often as necessary to control weeds during the summer before planting) is a simple, yet efficient way to improve both cottonwood plantation establishment and early growth on abandoned fields. Fallowing seems most beneficial to old fields with compacted and nutrient-depleted surface soils or on sites where herbaceous competition is severe.

Fallowing not only controls seedling and rhizome Johnson grass and other herbaceous species, but also improves the nutrient and moisture status of the soil. Summer fallowing may eliminate the need for second-year cultivation, a treatment that provides benefit to tree growth when competition from herbaceous vegetation is serious.

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Fallowing old fields the summer before planting eastern cottonwood significantly increased survival and growth through age 5.

Keywords: *Populus deltoides,* site preparation, fertilization, second-year cultivation, intensive culture.

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Estimated Losses Caused by Wood Products Insects During 1970 for Single-Family Dwellings in 11 Southern States

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U.S. Department of Agriculture
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Summary

In 1970, owners of single-family dwellings in 11 southern States spent an estimated $143 million (1976 dollars) to prevent and control subterranean termites and wood-destroying beetles. Losses incorporated into this estimate include: $79.4 million for corrective or remedial termite treatments, $13.8 million for preventive or pretreatment of termites, $12.9 million for remedial beetle treatments, and $37.0 million for contract renewals or damage insurance. Depending upon remedial costs and termite damage repair costs, an additional $12.3 million to $19.5 million for treatment and $38.6 million for damage repaired by someone other than the pest control industry could be added to the loss estimate. Also, the estimate would be increased significantly by adding losses in multifamily dwellings and nonresidential construction. Although loss from replacement of termite-damaged wood probably has decreased, expanded research application efforts can reduce losses further if current termite prevention and control measures remain available.

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Although we were helped by many people, the validity of the data and the expressed opinions are our responsibility. We used the charges shown for various pest control services for estimation purposes only, and we do not suggest they serve as "normal" charges for these services.

1979

Estimated Losses Caused by Wood Products Insects During 1970 for Single-Family Dwellings in 11 Southern States

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Introduction

Wood products insects (WPI), subterranean termites and various wood-destroying beetles, occur in all States and United States possessions except Alaska. Because WPI primarily attack seasoned, processed wood in use, these insects cause enormous economic losses, but data have never been compiled and published to document loss estimates for the nation or even for the South where these insects are most prevalent. Estimates of annual national losses from termite damage and control range from $100 million (Lund 1967) to $3.5 billion (USDA 1974), though $500 million is the figure most often quoted (Ebeling 1968). Annual national losses were estimated to be $17 million for damage by Lyctidae (Gerberg 1957) and $40 million for all beetles (Hatfield 1950).

For about 23 years, soil beneath houses has been treated with chlorinated hydrocarbon insecticides currently recommended for termite prevention and control (Smith and others 1972). Many treatments have been done and many houses have been built since Snyder's 1961 estimate of $250 million in damage annually to the nation's buildings was incorporated into the $500 million loss estimate (Ebeling 1968). Therefore, we think the total cost of controlling termites and repairing their damage needs to be reevaluated.

For the 11 southern States either in the high-hazard area for termites or bordering it (fig.1), this paper presents estimated numbers of WPI treatments during 1970 and their total cost in 1976 dollars. To document the basis for these estimates, we report and discuss 1962 and 1967 data on types of treatments (composition), damage repairs, and treatment costs in Arkansas, Georgia, and Tennessee; data on numbers of WPI treatments done annually from 1961-76 in these States and three additional ones; and data on numbers, value, and construction types of houses from the 1960 and 1970 census of housing.[1] Trends in treatment costs, treatment performance, and housing construction are discussed.

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[1] Number and median value of houses for each State were obtained from the HC(1)-B Series, Table 34, Detailed Housing Characteristics, U.S. Department of Commerce, Bureau of Census, 1972. The other housing data were obtained from the U.S. Summary, U.S. Census of Housing, HC(1) No. 1, Tables 5 and 7, 1963, and from the U.S. Summary, Detailed Housing Characteristics, HC(1)-B1, Tables 22 and 23, 1972.

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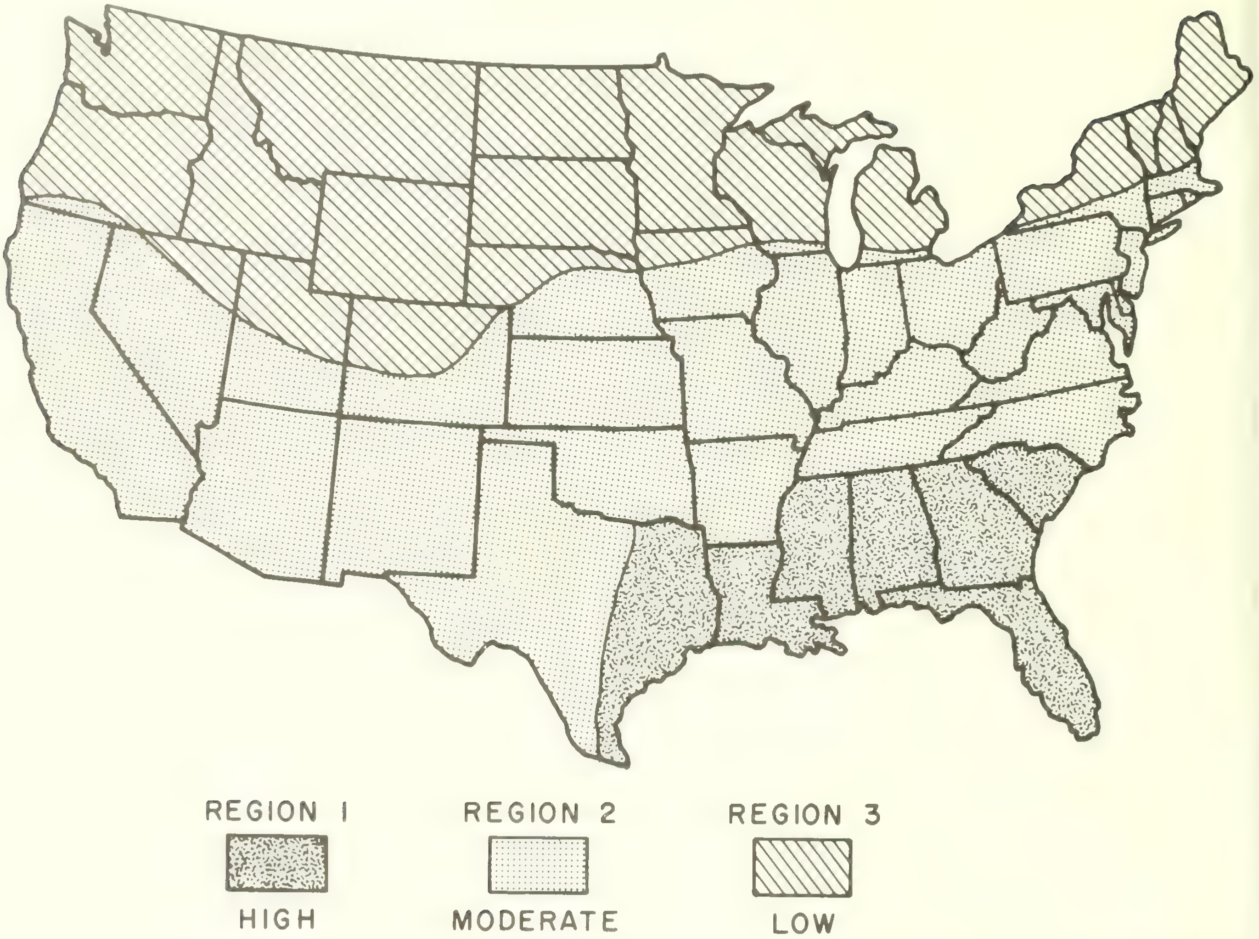
Figure 1.— *Geographical distribution of subterranean termite hazard regions.*



Methods

Data Gathered from States

Preliminary evaluation of reports and records from 18 States with structural pest control (SPC) laws revealed that only certain States had files containing sufficient information to use effectively in a survey. And other than for compiling yearly totals of treatments, available information had never been evaluated nor had comparisons been made among States. We obtained the number of treatments done annually from 1961-76 in Alabama, Arkansas, Georgia, Louisiana, Oklahoma, and Tennessee.

Because Arkansas, Georgia, and Tennessee records contained the most details on treatments, we obtained from these States sample data on treatment costs and composition, that is, whether the treatments were remedial or preventive for termites, beetles, or both insects combined.

In Arkansas, the record files contain every termite and beetle treatment contract, and the recorded data included: (1) date of treatment, (2) county, (3) type of framework, (4) type of wood-destroying organism, (5) extent of treatment, including installation of soil covers to reduce relative humidity in crawl spaces, (6) type of repairs, (7) cost of treatment and repairs, and (8) renewal contract costs. In Georgia and Tennessee, the files contain only monthly reports or work orders, so limited information was available on construction characteristics or repairs performed. Cost information was available in Tennessee but not in Georgia.

To determine trends in the treatments performed during the 1960's, in 1969 we recorded data for all treatments reported during 1962 and 1967 by every fourth pest control firm in Arkansas, Georgia, and Tennessee. The firms were selected from an alphabetical listing of all firms licensed for SPC in each State for each year. Overall, sample data were recorded from 32,639 of the total 160,438 treatments performed by 913 licensed firms. Data accuracy was verified by personal inspection of about 70 randomly selected homes in Arkansas and Georgia, and proved to be 87 to 100 percent correct.

How Estimates Were Made

Data were compiled and expanded for each State and year. For example, a Statewide estimate of the number of termite pretreatments for Arkansas in 1962, (X) was obtained by solving the proportion: number of pretreatments in recorded sample (447) is to the total number of termite treatments in the recorded sample (4,481) as X is to the constant 10,296, the total number of treatments reported in the State during 1962.

For the 1970 estimates, we calculated the percentage of houses treated in Alabama, Arkansas, Georgia, Louisiana, Oklahoma, and Tennessee by using the number of treatments reported in each State and the number of single-family dwellings in each State, as reported by the 1970 census. We estimated treatments for Florida, Mississippi, North Carolina, South Carolina, and Texas by applying the calculated treatment percentage for the other six States combined (2.73 percent) to the number of houses in each remaining State.

To estimate total cost in 1970, we first calculated how many treatments were remedial or preventive in each State by using the mean of 1967 composition data for Arkansas, Georgia, and Tennessee. We then estimated cost by multiplying the estimated number of remedial and pretreatments in each State by mean cost for such treatments in Arkansas and Tennessee.

Because State regulatory officials estimated most contracts were renewed for 5 years, we estimated renewal cost in 1970 on the basis of treatments performed in the preceding 5 years. We estimated total treatments and treatment composition in each State for 1965-69 by the same procedures used for obtaining the 1970 estimate. We found what percentage of the houses had been treated during 5 years in the six States with treatment reports, then used this percentage (12.73) to estimate treatments in the five remaining States. Regulatory officials estimated that 37 percent of the pretreatments and 67 percent of the remedial treatments are renewed, so we used these percentages to estimate the number of each type renewed. We then multiplied these estimates by the average renewal cost obtained from the Arkansas and Tennessee data.

Because 19 construction cost indexes suggested

Table 1. — *Composition and incidence of WPI treatments in Arkansas, Georgia, and Tennessee*

Data characteristics	Arkansas		Georgia		Tennessee		Total 1967 data
	1962	1967	1962	1967	1962	1967	only[1]
	Number						
Houses in State[2]	603,796	655,675	1,229,269	1,407,333	1,126,672	1,254,468	—
Licensed SPC firms	107	107	182	231	137	149	487
Total treatments	10,296	13,759	28,793	44,621	29,112	33,857	92,237
WPI treatment composition							
Remedial termites	8,066	7,669	21,737	24,671	23,798	26,020	58,360
Pretreatment termites	1,027	4,472	3,442	14,359	2,524	4,063	22,894
Remedial termites and beetles	703	1,248	1,850	3,507	2,466[3]	3,114[3]	7,869[3]
Remedial beetles	172	162	600	1,413	—	—	1,575
Totals	9,968	13,551	27,629	43,950	28,788	33,197	90,698
	Percent						
Remedial termites	82.3	57.3	77.7	57.2	82.7	78.4	64.3
Pretreatment termites	10.5	33.4	12.3	33.3	8.8	12.2	26.3
Remedial termites and beetles	7.2	9.3	9.9	9.4	8.6	9.4	9.4
Remedial beetles	1.7	1.2	2.1	3.2	—	—	2.2
WPI treatment incidence for total houses							
Remedial termites	1.3	1.2	1.8	1.7	2.3	2.3	1.7
Pretreatment termites	0.2	0.7	0.3	1.0	0.2	0.3	0.7
Remedial termites and beetles	0.1	0.2	0.2	0.3	0.2	0.2	0.2
Remedial beetles	<0.1	0.1	0.1	0.1	—	—	<0.1

[1] The mean percentages were used for the 1970 estimates.

[2] Twice the annual increase in houses from 1960-70 was added to the 1960 total for 1962 and subtracted from the 1970 total for 1967.

[3] Calculated from Arkansas and Georgia data.

1967 costs had increased from 86 to 124 percent (Levy 1977), we adjusted all 1967 mean treatment costs 100 percent for inflation. Renewal charges for annual inspection contracts, however, were only inflated 80 percent because we believed their cost was established during treatments in prior years and thus affected less by inflation.

Procedures for estimating beetle treatments are described by Williams and Smythe (1978).

Results And Discussion

Treatment Incidence, Composition, and Cost for Arkansas, Georgia, and Tennessee

The total number of WPI treatments in the three States increased 35 percent from 1962-67 (table 1). There were more treatments in 1967 than in 1962, primarily because of more termite pretreatments. In 1962, pretreatments were about 10.5 percent of all treatments, but by 1967 they were 26.3 percent. Remedial termite treatments increased only slightly.

Although the total number of treatments and total cost increased in Arkansas and Tennessee from 1962-67, the cost per treatment was less (table 2). Mean treatment cost was reduced more in Arkansas than in Tennessee, probably because more low-cost pretreatments were done in Arkansas.

With the extensive Arkansas data, we evaluated how repairs performed by the SPC industry affected remedial treatment costs (table 3). Fewer treatments included repairs in 1967 than in 1962, but the mean cost remained the same. For 69 percent of all treatments in 1962 and 70 percent in 1967, the cost was for the treatment itself and not repair of damages; the

Table 2. — *WPI treatment costs in Arkansas and Tennessee*

Cost for each type of treatment	Arkansas 1962	Arkansas 1967	Tennessee 1962	Tennessee 1967	1967 mean for all data combined[1]
Pretreatment termites					
Total	$ 58,352	$ 270,124	$ 130,045	$ 322,386	
Mean	58	59	57	60	60-(120)
Remedial termites only					
Total	1,251,845	1,083,568	3,361,900	3,339,280	
Mean	155	142	128	115	123-(246)
Remedial termites and beetles					
Total	141,314	269,359	5,597	46,393	
Mean	201	217	124	146	207-(414)
Remedial beetles only					
Total	20,870	16,514	4,885	1,014	
Mean	124	121	143	150	122-(244)
All treatments[2]					
Total	$1,496,883	$1,691,630	$3,618,066	$3,792,716	
Mean	145	123	124	111	114-(228)

[1] The figures enclosed by parentheses are 1967 costs inflated 100 percent to 1976 dollars.

[2] Includes miscellaneous treatments in addition to those listed.

Table 3. — *Remedial termite treatments in Arkansas in relation to damage repair*

Repair performance	Percent of all remedial treatments		Average treatment cost (dollars)	
	1962	1967	1962	1967
Not needed	68.7	69.6	131	132
Needed, not done	10.0	18.7	164	175
Done	16.8	9.8	223	230
Some done, more needed	2.9	1.8	228	317
Miscellaneous[1]	1.6	0.1	—	—
Weighted mean			153	153

[1] Treatments such as repairs and enclosing crawl space, no repairs and enclosure, spot treatment, or recall. Each category was less than 1.0 percent of the total number of remedial treatments which were 9,194 and 9,058 in 1962 and 1967, respectively.

Tennessee data also suggested this. Based on the difference in cost of treatment with and without complete repair done, repairs averaged $92 in 1962 and $98 in 1967. For 2 to 3 percent of the treatments, about $100 to $200 in repairs was done, but we had no way to determine the additional cost if all damage had been repaired. Extensive damage repair probably was needed with some but not necessarily all of the remaining 10 to 19 percent of the treatments. Although repairing termite damage to a home can cost thousands of dollars, most Arkansas homeowners apparently obtained effective control soon after termite infestations were noticed.

The potential cost of termite damage is rising with costs of materials and labor, but extensive damage probably occurs less frequently now because termite prevention and control treatments have become widely used through FHA and VA policies (Anon 1959) and the publicity efforts of the SPC industry. Surely, development of better equipment and treatment procedures during the past two decades has improved termite prevention and control services. However, houses continue to be designed and built with construction faults conducive to termite attack, many houses are not pretreated, and some are pretreated inadequately (Mountain 1977).

We think most homeowners, as Arkansas homeowners have done, obtain termite control services soon after detecting termite attacks, so damage repair expenditures should be kept to a minimum. Each year a few houses are partially treated to correct earlier improper remedial treatment, improper pretreatment, or disturbance of proper treatment by landscaping or remodeling. Therefore, we believe a mean remedial treatment cost that includes some allowance for damage repair and some allowance for partial retreatment of previously treated houses accurately represents current remedial control practices.

Reported WPI Treatments and Their Incidence for Six Southern States

For treatments reported during 1970, the percentage of houses treated varied from 1.1 percent in Oklahoma to 3.8 percent in Georgia, and means of treatments done during 1961-70 and during 1971-76 are much higher in some States than in others (table 4). Factors causing such trends include differences in termite incidence and State population growth rates. Numbers of treatments reported within a State fluctuate from year to year because of such factors as whether the year was good or bad for termite swarming or whether high construction activity increased numbers of pretreatments.

Although our data suggest more than 4 percent of the houses may have been treated in Georgia during some years since 1970, this percentage apparently is about the upper limit of treatment performance for a State like Georgia, which is heavily populated and in the high-hazard region. With the possible exception of Florida, more than 4 percent of the houses probably are not treated in any year in any of the 11 States. Unfortunately, Florida does not require reports of SPC treatments, so the exact level there cannot be determined.

If treatment activity remained at 3 percent of the houses every year for 20 years, 60 percent of all houses should have been treated, but many less probably were. If we compare the increase in numbers of houses from 1960 to 1970 with number of WPI treatments in six States, we see that many houses built during the 1960's were not pretreated (table 5). Some WPI treatments were retreatments; some were for beetles; and because some houses were demolished more houses were built than suggested by the increases. Assuming 1962 and 1967 are representative for the decade, less than 35 percent of new houses were pretreated in Arkansas and Georgia and less

Table 4.—*WPI treatments reported in six States during 1970 and mean numbers reported during 1961-70 and 1971-76*

Period	Alabama	Arkansas	Georgia	Louisiana	Oklahoma	Tennessee
			Number			
1970	35,815	16,250	55,291	27,000	10,297	38,232
1961-70 $\bar{x}$	29,490	13,758	44,218	23,080	14,637	33,876
1971-76 $\bar{x}$	42,612	24,071	69,718	31,151	17,711	43,079
			Percentage of houses treated			
1970	3.2	2.4	3.8	2.4	1.1	2.9
1961-70 $\bar{x}$[1]	2.8	2.2	3.3	2.2	1.7	2.8
1971-76 $\bar{x}$[2]	3.8	3.8	4.7	2.7	1.9	3.3

[1] The percentages shown are based on the mean of the number of houses reported for the 1960 and 1970 census in each State.

[2] These percentages, based on 1970 houses, are higher than the actual levels of treatments done because some treatments were retreatments of previously treated houses and some were pretreatments of new houses built since 1970.

Table 5. — *Comparison of the increase in houses from 1960-70, reported WPI treatments, and estimated pretreatments in six States*

State	Increase in houses from 1960-70	Reported treatments	Estimated pretreatments[1]
Alabama	147,328	331,696	72,641
Arkansas	86,463	137,581	30,130
Georgia	296,772	442,181	102,586
Louisiana	167,680	230,779	50,540
Oklahoma	122,179	146,164	15,347
Tennessee	212,660	329,637	34,611
Total	**1,033,082**	**1,618,038**	**305,855**

[1] Pretreatments in Alabama, Arkansas, and Louisiana are estimated as 21.9 percent from 1967 data in Arkansas; number in Georgia as 23.2 percent from 1967 data in Georgia; and number in Oklahoma and Tennessee as 10.5 percent from 1967 data in Tennessee.

than 17 percent in Tennessee.

Treatment numbers increased markedly from 1961-72 then decreased, probably because of the recession in housing construction (fig. 2). The increase since 1974 suggests more pretreatments are now being done.

Estimates of Southwide WPI Treatments

In table 6, termite treatments for 1970 and WPI treatments for 1965-69 are the number reported in six States and estimates for the remaining States. In all States, however, the composition of termite treatments is estimated as the same as the mean 1967 composition for Arkansas, Georgia, and Tennessee except that remedial treatments for termites treated alone have been combined with those for termites and beetles.

Most termite prevention or control treatments include a warranty or insurance for future damage, provided an inspection contract is purchased annually. For example, over 2 million termite treatments were done in the 11 States from 1965-69, and an estimated 1.2 million were renewed annually (table 6). Most were remedial treatments with the annual inspection charge often being a percentage of the initial treatment cost.

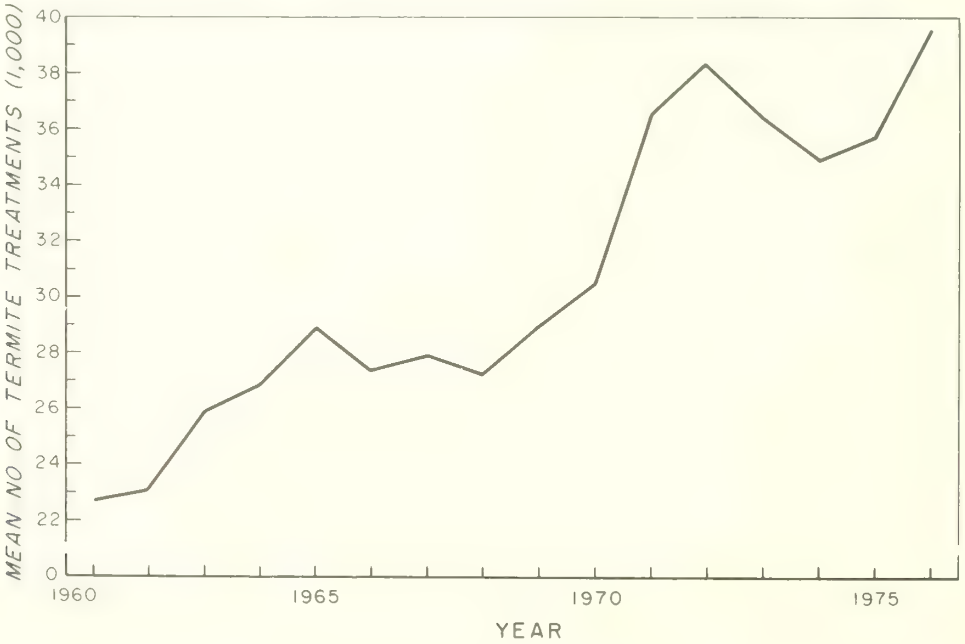


Figure 2. — *Trend in numbers of treatments annually reported to regulatory offices in Alabama, Arkansas, Georgia, Louisiana, Oklahoma, and Tennessee during 1961-76.*

Table 6. — *Estimated number of remedial or pretreatments for termites in 1970, WPI treatments for 1965-69, and estimated number of contracts renewed annually in 11 southern states*

State[1]	Houses in 1970	Termite remedial treatments	Termite pretreatments	WPI treatments 1965-69	WPI contract guarantees renewed[2]
Alabama	1,114,845	26,389	9,426	167,476*	99,145
Arkansas	672,967	11,831	4,227	75,852*	44,904
Florida	2,490,838	50,101	17,899	316,835	187,567
Georgia	1,466,687	39,447	14,091	231,517*	137,058
Louisiana	1,146,105	19,894	7,106	122,380*	72,449
Mississippi	697,271	14,025	5,010	88,693	52,506
North Carolina	1,619,548	32,577	11,637	206,006	121,955
Oklahoma	937,815	7,587	2,710	74,804*	44,284
South Carolina	804,858	16,190	5,783	102,378	60,608
Tennessee	1,297,000	28,169	10,063	171,825*	101,720
Texas	3,809,086	76,618	27,370	484,516	286,833
Total	**16,057,020**	**322,828**	**115,322**	**2,042,282**	**1,209,029**

[1] Sums of reported treatments in States asterisked were 2.73 percent for termite treatments in 1970 and 12.73 percent for total WPI treatments of all houses in the six States from 1965-69. To estimate treatments in each of the five remaining States we applied these percentages to number of houses in 1970 in each State.

[2] Twenty-six percent of the treatments were considered pretreatments and about 37 percent of these were renewed. Estimated 67 percent of the remedial treatments were renewed. Percentages of renewal are estimates of regulatory officials.

Estimates of Treatment and Renewal Costs

The combined total cost of WPI treatments in 1970 for the 11 States is $143.1 million when inflated 100 percent to 1976 dollars (table 7). Figure 3a shows the composition of WPI treatments when termites and beetles could be treated with the same insecticides.

Now, however, termites and beetles must be treated separately. Figure 3b shows the 1970 composition if each treatment of beetles and termites together is considered as two separate treatments. Remedial beetle control becomes 10.8 percent of all treatments and 9.0 percent of total monetary loss (fig.4). Termite pretreatments represent 13.5 percent of all treatments, but because they are inexpensive, they make up only 9.7 percent of the total monetary loss. Contract renewal charges are 25.8 percent of the total loss estimate for WPI and 28.4 percent of that for termites.

We believe the $130.2 million loss estimate for termites reasonably represents losses in single-family dwellings. Our means for pretreatment and contract renewal — $60 and $17 — compare favorably with the 1970 National Pest Control Association (NPCA) means — $63.79 and $18.76 (renewal of remedial) or $18.07 (renewal of pretreatment), but our estimates suggest that fewer contracts were renewed than

Table 7. — *Estimated costs of wood-destroying insect treatments in 1970, after 100 percent inflation to 1976 dollars*

State	Termite remedial treatments	Termite pretreatments	Beetle remedial treatments	Renewal contracts	Total for all costs
	---------- thousands of dollars ----------				
Alabama	6,492	1,131	1,119	3,034	11,776
Arkansas	2,910	507	414	1,374	5,205
Florida	12,325	2,148	1,908	5,740	22,121
Georgia	9,704	1,691	1,653	4,194	17,242
Louisiana	4,894	853	921	2,217	8,885
Mississippi	3,450	601	659	1,607	6,317
North Carolina	8,014	1,396	1,415	3,732	14,557
Oklahoma	1,866	325	274	1,355	3,820
South Carolina	3,983	694	752	1,855	7,284
Tennessee	6,930	1,208	919	3,113	12,170
Texas	18,848	3,284	2,869	8,777	33,778
Total	**79,416**	**13,838**	**12,903**	**36,998**	**143,155**

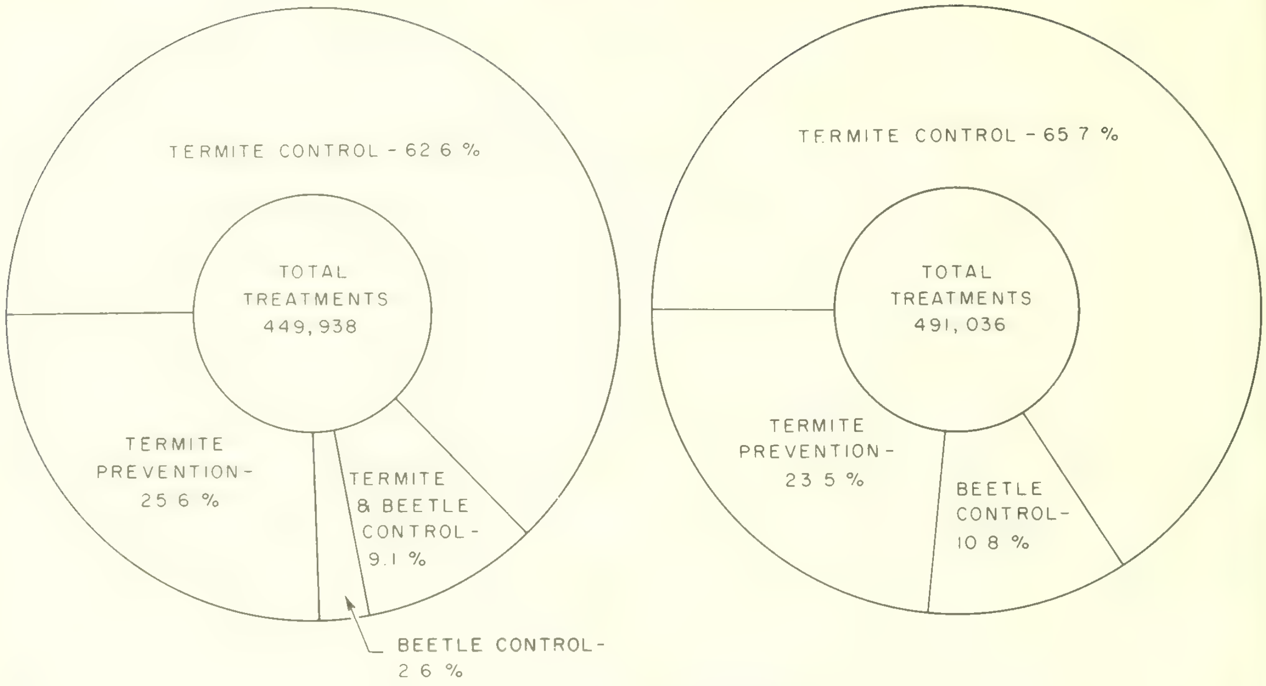


Figure 3. — *Percent composition of total WPI treatments in 1970: (a) when the same insecticides were used for treating termites and beetles, and (b) now when each must be treated separately.*

NPCA estimated.[2] We can assume that more pretreatments are being done now than in the years our samples were taken. And because our estimates are based on 1967 composition, our 1970 estimates may be slightly low. The trend toward more pretreatments should reduce the number of costly remedial treatments needed.

Because of variations in construction characteristics, labor costs, and extent of repairs, remedial treatment cost and damage repair expenses are portions of total losses most difficult to estimate accurately. Remedial control cost estimates for the 11 States are: $79.4 million with the $246 mean of 1967 remedial treatment costs from Arkansas and Tennessee inflated 100 percent; $91.7 million with the $284 mean of 280,510 treatments performed during 1977 throughout the nation;[3] or $98.9 million with the 1967 mean remedial cost in Arkansas inflated 100 percent (table 3).

Because we lack data on the present composition of treatments and performance of repairs, we think the $79.4 million estimate is preferable because it was derived with a mean that represents some damage repair expense and includes some low-cost partial treatments. Though arbitrarily inflated and derived from data for only two southern States, the $246 mean does represent over 6000 sample treatments by about 250 SPC firms, and it was selected after evalu-

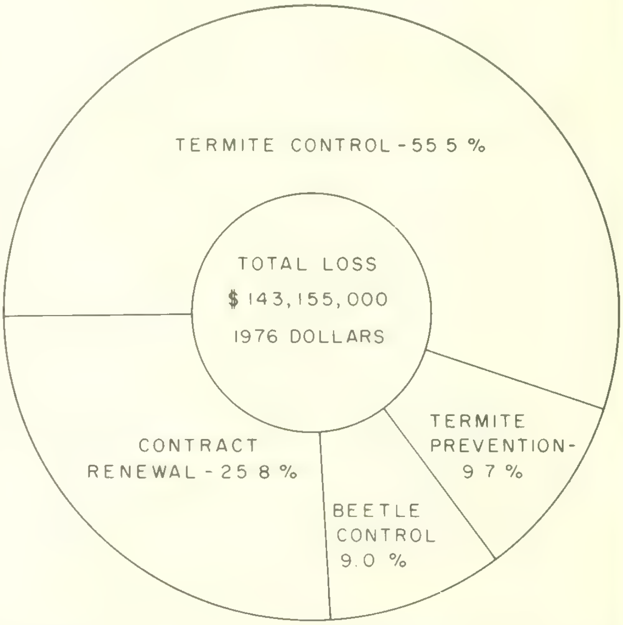


Figure 4. — *Type of WPI treatment and percent that each (including contract renewal) contributed to total loss in 1970.*

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[2] National Pest Control Association correspondence, from: NPCA Staff, To: Marketing Management Committee, Wood Destroying Organisms Committee, Subject: Termite Survey Results, dated January 22, 1970.

[3] Correspondence dated June 14, 1978, from Dr. Philip J. Spear, Senior Director, Research National Pest Control Association, to Lonnie H. Williams.

ation of repairs performed with over 2000 treatments.

For expenses of damage repair done by someone other than the SPC industry, we derived an estimate of $38.6 million by applying the repair performance percentages in Arkansas (table 3) to the 322,828 remedial treatments in the 11 States during 1970. Our estimate assumes 70 percent required no repairs, 10 percent required repairs costing $196 per treatment (adjusted for inflation), and the remainder presumably cost $500 each in repairs.

Our loss estimates (fig. 4) would be increased significantly by adding losses to multifamily dwellings, commercial establishments, public buildings, buildings maintained by the military, and by some allowance for costs of preserving poles, pilings, and posts. Many houses have been built since 1970 and more treatments are now being done, but because a greater proportion of treatments performed now probably are low-cost pretreatments, the total loss has not necessarily increased. Changes in construction also may influence losses. From 1960-70 in the 11 States, the number of houses built on concrete slabs or with basements increased 14.8 percent and 2.1 percent respectively. Remedial treatment costs will be high for such construction because applying insecticides beneath existing slabs or basements is difficult.

We have contributed toward documenting termite-caused losses in the region where hazard is greatest, but documenting national loss estimates and showing differences by hazard region require data on treatment incidence, composition, and costs for Hawaii, for some of the 14 States in Region 3 and for some of the 23 remaining States in Region 2 (fig. 1). In 1970, there were about 15.3 million single-family dwellings in Region 3 and about 36 million in Region 2, but treatment totals by State were only available in California and Kentucky (Smythe and Williams 1974), though Kansas has made survey estimates.[4]

For 1970 in the 11 States, the median value of single-family dwellings ranged from $6.2 billion in Arkansas to $46.5 billion in Texas and totaled over $200 billion. Because the 1970 median value of $17,000 had risen to $27,200 by 1974 and because houses built since 1970 have an estimated median value of $36,300 (Myrtle 1976), the total value now exceeds $400 billion. Use of effective controls has reduced estimated termite-caused losses to much less than 0.1 percent of the total housing value. However, our estimates suggest nearly 8.5 times more money is being spent on remedial control and damage repair than on prevention. Because a median valued house can be protected through pretreatment for less than 0.5 percent of its value, we believe expanded research application efforts would reduce losses further.

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Williams, Lonnie H., and Richard Smythe.

1978. Estimated losses caused by wood products insects during 1970 for single-family dwellings in 11 southern States. U.S. Dep. Agric. For. Serv. Res. Pap. SO-145, 10 p. South. For. Exp. Stn., New Orleans, La.

Estimates based on data from State regulatory agencies suggest owners of single-family dwellings in 11 southern States spent about $143 million (1976 dollars) in 1970 to control subterranean termites and wood-destroying beetles. Losses incorporated into this estimate include: $79.4 million for remedial termite treatments, $13.8 million for pretreatment for termites, $12.9 million for remedial beetle treatments, and $37.0 million for contract renewals.

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Tool Forces and Chip Types In Orthogonal Cutting Of Southern Hardwoods

BY G. E. WOODSON

Southern
Forest
Experiment
Station

SUMMARY

Specimens (1/8 to 1/4 inch thick) from 5 trees of each of 22 hardwood species were cut orthogonally at 5 inches per minute. Average parallel and normal cutting forces for various rake angles (50, 60, and 70 degrees for veneer; 10, 20, and 30 degrees for planing; 20, 30, and 40 degrees for crosscutting) were measured at three moisture contents (10 percent, 20 percent, and saturated) and four depths of cut (.015, .030, .045, and .060 inch). Average parallel forces generally increased with deeper cuts and greater specific gravity but decreased with greater rake angle and moisture content. Average normal forces increased with deeper cuts but were unrelated to specific gravity, moisture content, or rake angle when cuts were in the veneer direction. In the crosscutting and planing directions, average normal forces decreased algebraically with increasing rake angle and changed from positive to negative between 20 and 30 degrees, decreased with increasing moisture content, and increased in magnitude with increasing specific gravity. The general conclusions about chip types that follow are the result of observations made throughout the study:

Chip Type

Planing—Crushing occurred at low rake angles in low density diffuse porous hardwoods.
Cantilever-type failure occurred in all species at high rake angles and low moisture content.
Continuous chip formed when making thin cuts and also at intermediate rake angle (20°).

Veneer—Continuous veneer formed at high rake angle in saturated wood.

Crosscut—Smooth cut made at high rake angle and high moisture content.

1979

Tool Forces and Chip Types In Orthogonal Cutting Of Southern Hardwoods

BY G. E. WOODSON

The objectives of the study reported here were to determine average parallel and perpendicular tool forces and observe chip formation during orthogonal cutting of 22 species of hardwoods commonly found on southern pine sites. Basic aspects of machining such as chip formation, surface quality, and tool life can be better understood with knowledge of the forces needed during orthogonal cutting.

Orthogonal cutting is the machining process in which the cutting edge is perpendicular to the relative motion of tool and workpiece. (See figure 1 for nomenclature used in orthogonal cutting.) A two-number notation introduced by McKenzie (1961) is useful for describing the process. In this notation, the first number indicates the orientation of the cutting edge with respect to the grain, and the second number indicates the direction of movement of the cutter. Thus, planing has the simple notation of 90-0. The first number indicates the cutter edge is perpendicular to the grain direction and the second number indicates the movement of the cutter is parallel to the grain direction. Similarly, veneer cutting is 0-90 and crosscutting is 90-90 (fig. 2).

Variables for which cutting forces were measured are as follows:

- I. Twenty-two species (table 1)
- II. Cutting direction
  - A. Veneer (0-90)
  - B. Planing (90-0)
  - C. Crosscut (90-90)
- III. Moisture content
  - A. Equilibrium at 50 percent R.H.
  - B. Equilibrium at 83 percent R.H.
  - C. Saturated
- IV. Rake angle
  - A. 50°, 60°, and 70° with 0° clearance angle (Veneer direction)
  - B. 10°, 20°, and 30° with 15° clearance angle (Planing direction)
  - C. 20°, 30°, and 40° with 15° clearance angle (Crosscut direction)
- V. Depth of cut (inch)
  - A. 0.015
  - B. .030
  - C. .045
  - D. .060
- VI. Replications—one from each of five trees per species

Collection, Preparation, and Machining of Material

Material for the study was selected from logs collected by Manwiller[1] from throughout the South. The collection consisted of 10 trees from each of 22 species and was representative of 6-inch hardwoods growing on southern pine sites.

Three specimens for machining were prepared for each cutting direction from each of five logs (selected randomly) per species. One specimen per cutting direction was conditioned at 50 percent R.H., another at 83 percent R.H., and the remaining specimen was saturated.

Specimens for veneer cutting were 1/4-inch wide along the grain and cutting distance was at

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[1] Manwiller, F. G. 1972. Collection plan for a series of studies characterizing wood and bark properties of 22 species of low-grade hardwoods growing on southern pine sites. U.S. Dep. Agric. For. Serv., South. For. Exp. Stn., Study Plan FS-SO-3201-1.38, 11 p.

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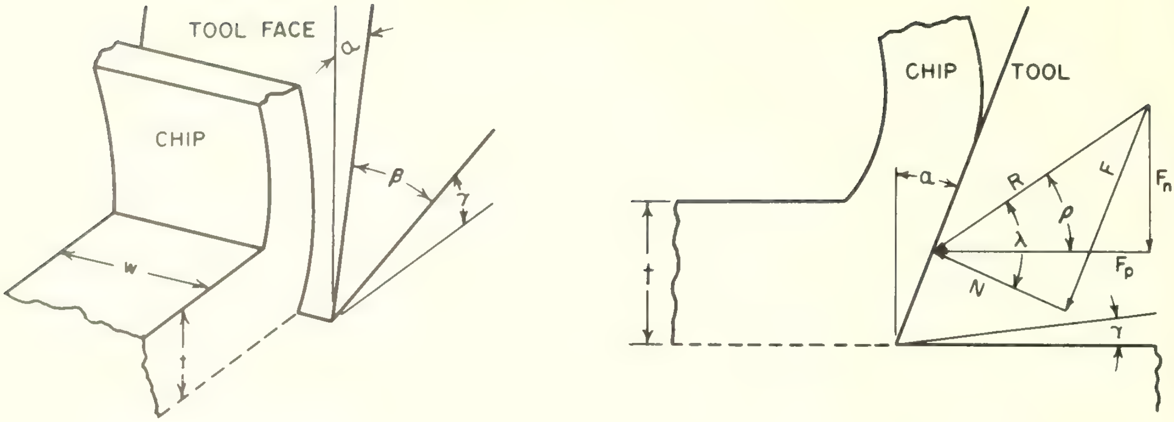

Figure 1.—*Nomenclature in orthogonal cutting.*

α — *Rake angle: angle between the tool face and a plane perpendicular to the direction of tool travel.*

β — *Sharpness angle: angle between the tool face and back.*

γ — *Clearance angle: angle between the back of the tool and the work surface behind the tool.*

t — *Nominal chip thickness; depth of cut.*

w — *Width of undeformed chip.*

F_n — *Normal tool force: force component acting perpendicular to parallel tool force and perpendicular to the surface generated.*

F_p — *Parallel tool force: force component acting parallel to tool motion in workpiece, i.e., parallel to cut surface.*

R — *Resultant tool force: the resultant of normal and parallel tool force components.*

ρ — *Angle of tool force resultant: the angle whose tangent is equal to the normal tool force divided by the parallel tool force.*

F — *Friction force: force component acting along the interface between tool and chip.*

N — *Normal to the friction force: force component acting normal to tool face.*

λ — *Angle between resultant tool force and the normal frictional force; the angle whose tangent is equal to the friction force divided by the normal friction force.*

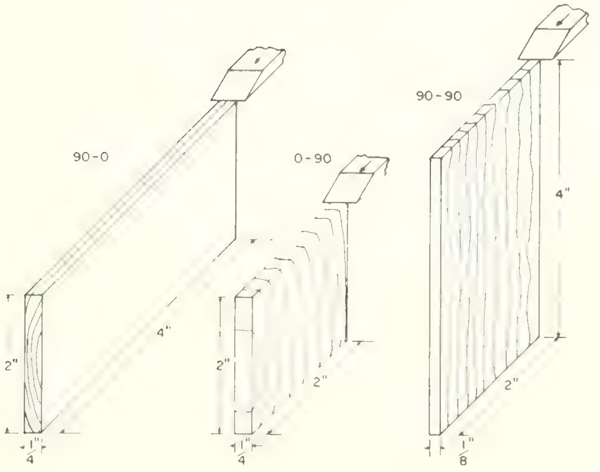

Figure 2.—*Specimens for orthogonal cutting.*

least 2 inches in a radial direction toward the log center. Crosscut specimens were cut radially, as in quarter sawn lumber, about 1/8-inch thick by 2 inches wide and 4 inches along the grain. Planing specimens were 1/4-inch thick by 2 inches wide by 4 inches along the grain and machining was done in the radial face (fig. 2).

Specimens were machined in random order within a moisture content. Effects of change in moisture content of surface fibers were minimized by keeping the specimens in the desired environment until test cuts were to be made. Cuts were made in sequence from 0.015 to 0.060 inch after one or, when roughness made it necessary, more smoothing cuts. Knives were sharpened with an Arkansas stone after each sequence of four cuts.

Instantaneous tool forces were measured with a two-component tool dynamometer[2] (fig. 3) connected to a multi-channel oscillographic recorder. The dynamometer was calibrated by suspending known weights on a dummy knife. Thus, normal and parallel tool forces were recorded in terms of pen deflection and converted to load in pounds by use of a calibration equation. A normal force was considered negative when the knife tended to lift the workpiece (i.e., deflected toward the workpiece) and positive when the knife deflection was away from the workpiece. The dynamometer was attached to a modified grinding machine and was positioned to allow movement of the workpiece past the dynamometer at 5 inches per minute. The workpiece, fixed in an air actuated vise attached to the grinding-machine table, was trimmed with a thin cut before adjustment for initial experimental cuts. For each cut, cutting forces were determined from the oscillographic recordings as illustrated in figure 4.

To generalize the data and make them more meaningful, cutting forces were correlated with specific gravity by linear regression analysis. Further generalizations were made to include only typical rake angles and wood moisture conditions for a particular cutting direction.

Moisture content and specific gravity were determined from the material left after all cuts were made; specific gravity (ovendry weight and green volume) was determined on saturated specimens only. Saturated specimens were cut from wood adjacent to specimens conditioned at 50 and 83 percent relative humidity and were therefore considered identical.

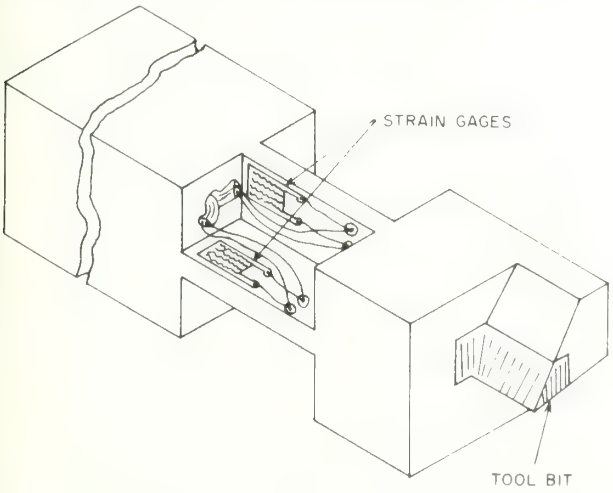

Figure 3.—*Sketch of a two-component tool dynamometer.*

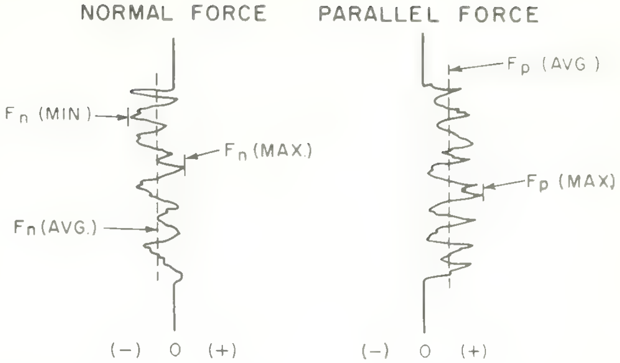

Figure 4.—*Illustration of method for obtaining cutting forces from typical oscillographic force patterns.*

Results

Appendix tables contain values for average and maximum parallel tool forces and average, maximum, and minimum normal tool forces by species, rake angle, moisture content, and depth of cut.

Average moisture contents and specific gravities of saturated samples are shown by species in text table 1. Specimens conditioned at 50 percent relative humidity averaged 10.90 percent and those conditioned at 83 percent averaged 18.85 percent moisture content.

Yellow-poplar and red oak were chosen to illustrate the effects of rake angle and moisture content on average parallel and normal tool forces. These species were selected to show the differences between a low density diffuse-porous hardwood (yellow-poplar) and a high density ring-porous hardwood (southern red oak).

As expected, average cutting forces were generally greater in southern red oak than in yellow-poplar (tables 2 and 3). For both species, average parallel forces usually decreased with higher moisture content and greater rake angle. Variation in normal force patterns was usually caused by formation of different chip types.

Average normal forces for cutting veneer were quite variable. Normal forces for planing and crosscutting changed from positive to negative as rake angle increased from 20° to 30°; in Woodson and Koch (1970) we found similar results in orthogonal cutting of southern pine earlywood

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[2] I thank N. C. Franz for providing the dynamometer used in this study. He is with the Faculty of Forestry, University of British Columbia, Vancouver, B. C.

Table 1.—*Specific gravity (ovendry weight and green volume) and average saturated moisture content of 22 southern hardwoods.*

	Moisture content percent	Specifi gravity
White oak (*Quercus alba* L.)	81	0.644
Winged elm (*Ulmus alata* Michx.)	89	.642
Hickory, true (*Carya* spp.)	92	.640
Post oak (*Q. stellata* Wangenh.)	80	.636
Northern red oak (*Q. rubra* L.)	88	.626
Blackjack oak (*Q. marilandica* Muenchh.)	118	.626
Shumard oak (*Q. shumardii* Buckl.)	90	.620
Scarlet oak (*Q. coccinea* Muenchh.)	92	.618
Southern red oak (*Q. falcata* Michx.)	91	.618
Cherrybark oak (*Q. falcata* Michx. var. *pagodaefolia* Ell.)	92	.609
Black oak (*Q. velutina* Lam.)	94	.598
Laurel oak (*Q. laurifolia* Michx.)	92	.597
White ash (*Fraxinus americana* L.)	104	.577
Water oak (*Q. nigra* L.)	101	.573
Green ash (*F. pennsylvanica* Marsh.)	107	.562
American elm (*U. americana* L.)	106	.551
Hackberry (*Celtis* spp.)	115	.541
Black tupelo (*Nyssa sylvatica* Marsh.)	121	.501
Red maple (*Acer rubrum* L.)	132	.489
Sweetbay (*Magnolia virginiana* L.)	140	.442
Sweetgum (*Liquidambar styraciflua* L.)	145	.439
Yellow-poplar (*Liriodendron tulipifera* L.)	157	.376

Table 2.—*Average parallel* (F_p) *and normal* (F_n) *tool force per 0.1 inch of knife for orthogonally cutting yellow-poplar at .030 inch depth of cut, with three knives in each of three directions, at three moisture contents and five replications.*

Cutting direction and rake angle		Moisture Content					
		10%		20%		Saturated	
		F_p	F_n	F_p	F_n	F_p	F_n
		pounds					
Veneer	50°	2.20	.05	2.12	−.08	1.84	.10
	60°	1.93	−.28	2.02	−.38	1.70	−.12
	70°	1.89	.18	1.98	.12	1.49	.28
Planing	10°	20.12	4.66	15.36	4.81	12.81	5.67
	20°	18.59	2.34	13.90	1.81	10.24	1.61
	30°	10.74	−.66	11.69	−.08	7.53	.81
Crosscut	20°	18.73	4.07	22.12	2.24	15.47	1.34
	30°	16.74	1.34	15.04	−.30	12.78	−.10
	40°	12.27	−1.03	12.27	−1.80	8.08	−1.10

Table 3.—*Average parallel* (F_p) *and normal* (F_n) *tool forces per 0.1 inch of knife for orthogonally cutting southern red oak at .030 inch depth of cut, with three knives in each of three directions, at three moisture contents and five replications.*

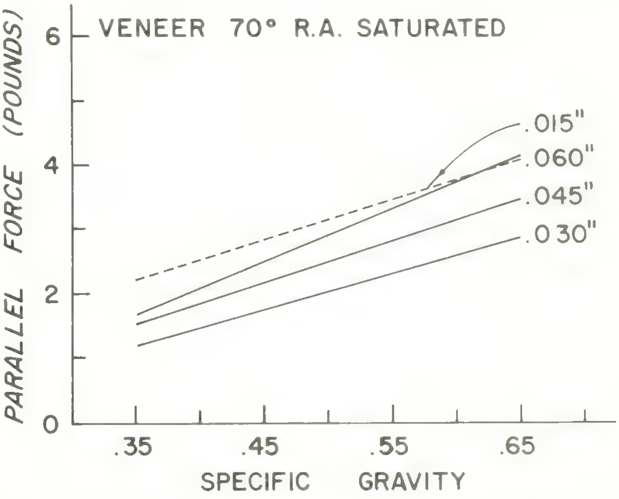
Cutting direction and rake angle		Moisture content					
		10%		20%		Saturated	
		F_p	F_n	F_p	F_n	F_p	F_n
		pounds					
Veneer	50°	6.12	.19	4.57	−.48	3.76	−.26
	60°	6.40	.35	3.83	−1.16	3.19	−.82
	70°	4.72	.29	3.39	−.08	2.49	.09
Planing	10°	37.97	10.15	22.46	5.54	18.90	4.55
	20°	32.78	3.05	19.11	1.74	14.23	1.18
	30°	21.47	−1.29	11.38	−.71	8.91	−.37
Crosscut	20°	43.01	2.89	31.01	1.04	25.30	.52
	30°	37.03	−3.03	25.74	−2.57	17.13	−2.02
	40°	26.86	−6.74	18.86	−4.78	14.05	−3.93

and latewood. Generally, average normal forces for planing and crosscutting were much lower than average parallel forces and decreased algebraically with increased rake angle and moisture content. Although normal forces decreased algebraically with increasing rake angle, their magnitude at the higher rake angles were sometimes larger but changed from positive to negative.

Veneer Cutting: 0-90 Direction

Average parallel force was consistently highest for the thinnest cuts (.015-inch) (fig. 5). Thinner cuts and cuts in saturated wood generally produced continuous chips with the knife continuously in the wood (fig. 6A). Conversely, the thickest cuts and cuts in dry wood generally produced discontinuous chips (fig. 6B) with the knife disengaged from the wood much of the time. Thus, discontinuous chips could produce higher maximum parallel forces and yet have lower average parallel forces. Averaged over all depths of cut, diffuse-porous hardwoods generally yielded chips that were slightly more continuous than ring-porous hardwoods.

When cut radially, ring-porous hardwoods exhibit zones of weakness in thin-walled earlywood cells. As the knife edge approaches the earlywood zone, stresses build until the chip fails as a cantilever beam (fig 6B). These zones of weakness are not present if the cuts are made tangentially (fig. 6C). To eliminate the problems associated with cutting all latewood or all earlywood, cutting in the tangential direction was not included in this study.



Depth of cut	y-intercept	Slope	r
---inch---			
.015	.04	6.21	.49
.030	−.71	5.47	.87
.045	−.78	6.55	.91
.060	−1.23	8.22	.93

Figure 5.—*Relationship of average parallel cutting force per 0.1-inch knife length with specific gravity (ovendry weight and green volume) for veneer cutting saturated wood of 22 species with a 70° rake angle (0° clearance angle) at four depths of cut. The dotted line indicates regression significant at .05 level; others are significant at .01 level.*

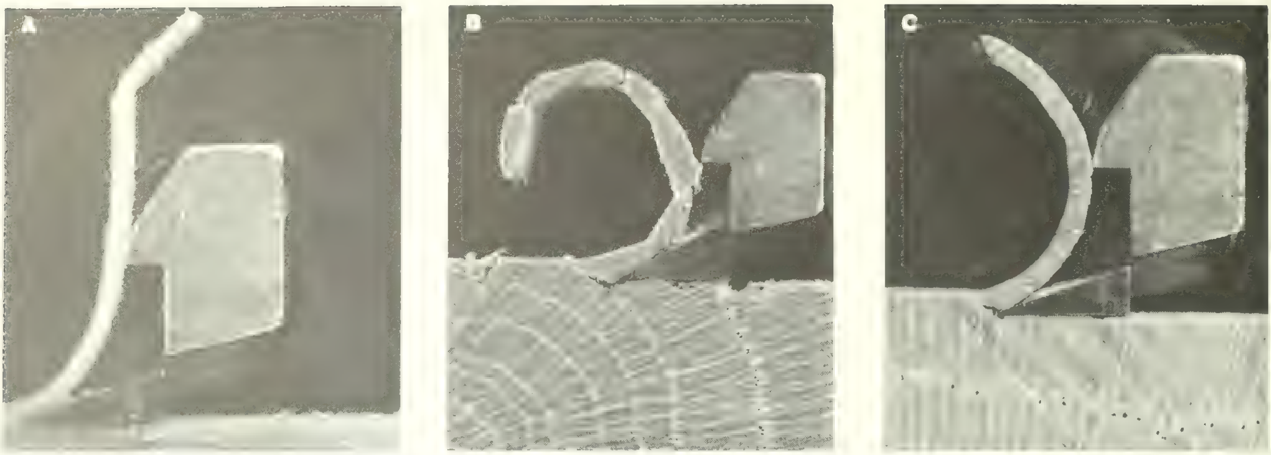


Figure 6.—*Typical chip types resulting from orthogonal cutting in the veneer direction (0-90). A. Continuous veneer in saturated red maple cut .030-inch deep with 70° rake angle and 0° clearance angle. B. Cantilever beam type failure in dry (11.4 percent) cherrybark oak cut .045-inch deep with 60° rake angle and 0° clearance angle. C. Continuous veneer in dry (11.4 percent) cherrybark oak cut tangentially .060-inch deep with 70° rake angle and 0° clearance angle.*

Among the species, average normal forces were not correlated with specific gravity, moisture content, or rake angle but increased with deeper cuts. Average parallel forces increased with deeper cuts and with higher specific gravity but decreased with increased rake angle and moisture content.

To summarize the effects of the principal factors (depth of cut, moisture content, and rake angle), the tool forces were averaged over all other variables (table 4). In general, maximum parallel forces for veneer cutting were about twice as large as the average forces. Maximum and minimum forces generally were similar in magnitude but opposite in sign.

Planing: 90-0 Direction

As expected, average parallel and normal forces increased with increasing depth of cut and with increasing specific gravity when dry wood was planed with a 10° rake angle (fig. 7). At low rake angle, chips were continuous (fig. 8A) and normal forces were positive (i.e., the knife was pushing the workpiece). As rake angle increased, the normal forces became more and more negative and produced broken chips (i.e., broken as a cantilever beam as in figure 8B). A combination of low rake angle and low wood specific gravity produced extensive crushing ahead of the knife and a chip similar to that shown in figure 8C. In those species exhibiting interlocked grain (such as black tupelo and the elms), high rake angles produced tearing ahead of the knife and left a rough surface (fig. 8D).

As rake angle increased, the normal forces changed from positive to negative. This transition occurred at about 20°; consequently, the relationship between average normal force and specific gravity was not significant with a 20° rake angle. The 30° rake angle produced increasingly negative cutting forces as the specific gravity increased.

Maximum parallel forces appeared to be about 30 percent greater than the average parallel forces (table 5). Similarly, the maximum normal forces were 30 to 40 percent greater than the average normal forces.

Crosscut: 90-90 Direction

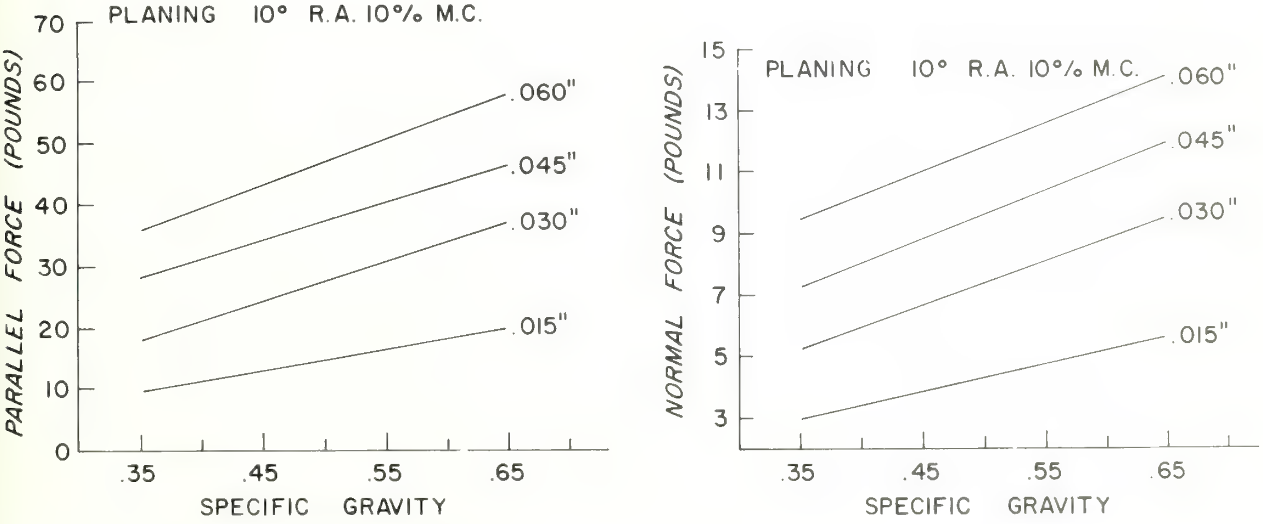
Average parallel force increased with increasing depth of cut and specific gravity (fig. 9). Generally, average normal forces were positive for specific gravity below 0.50 and negative for specific gravity above 0.50. For specific gravity greater or less than 0.50, normal force increased with depth of cut.

Average normal forces changed from positive to negative as rake angle increased from 20 to 30 degrees (table 6). The maximum parallel forces were about 23 percent greater than average parallel forces.

Uniform chips and smooth surfaces were produced with high rake angles in all types of wood (fig. 10A). Low rake angles in dry wood produced very rough surfaces with considerable failure beneath the plane of the knife cut (fig. 10B). Low density species (of all moisture contents) cut with low rake angles produced chips less than the desired thickness because the knife skimmed over the surface and did little cutting (fig. 10C).

Table 4.—*Tool forces when orthogonally cutting in the veneer direction with various depths of cut, moisture contents, and rake angles. Values are averaged over all other variables.*

Principal factor	Parallel force Average	Parallel force Maximum	Normal force Average	Normal force Maximum	Normal force Minimum
	Pounds/0.1 inch				
Depth of cut, inches					
.015	3.1	6.2	0.0	1.3	−1.0
.030	3.5	7.2	− .2	1.2	−1.3
.045	4.2	9.0	− .5	1.2	−1.9
.060	4.9	10.6	− .7	1.3	−2.4
Moisture content, percent					
10.9	4.7	10.8	0.0	2.0	−1.6
18.9	4.0	8.0	− .6	1.0	−1.9
104.3	3.1	6.0	− .4	.7	−1.4
Rake angle, degrees					
50	4.1	9.3	−0.2	1.5	−1.5
60	3.9	8.0	− .5	1.0	−1.9
70	3.9	7.4	− .3	1.2	−1.6



Depth of cut	Average parallel force y-intercept	Slope	r	Average normal force y-intercept	Slope	r
---inch---						
.015	−2.24	33.79	.87	.03	8.61	.80
.030	−3.20	61.68	.89	.22	14.34	.84
.045	7.55	59.38	.74	1.83	15.44	.75
.060	10.40	73.26	.79	3.94	15.63	.67

Figure 7.—*Relationship of average parallel and normal cutting force per 0.1-inch knife length with specific gravity (ovendry weight and green volume) for planing dry wood (10 percent moisture content) of 22 species with a 10° rake angle (15° clearance angle) at four depths of cut. All regressions are significant at .01 level.*

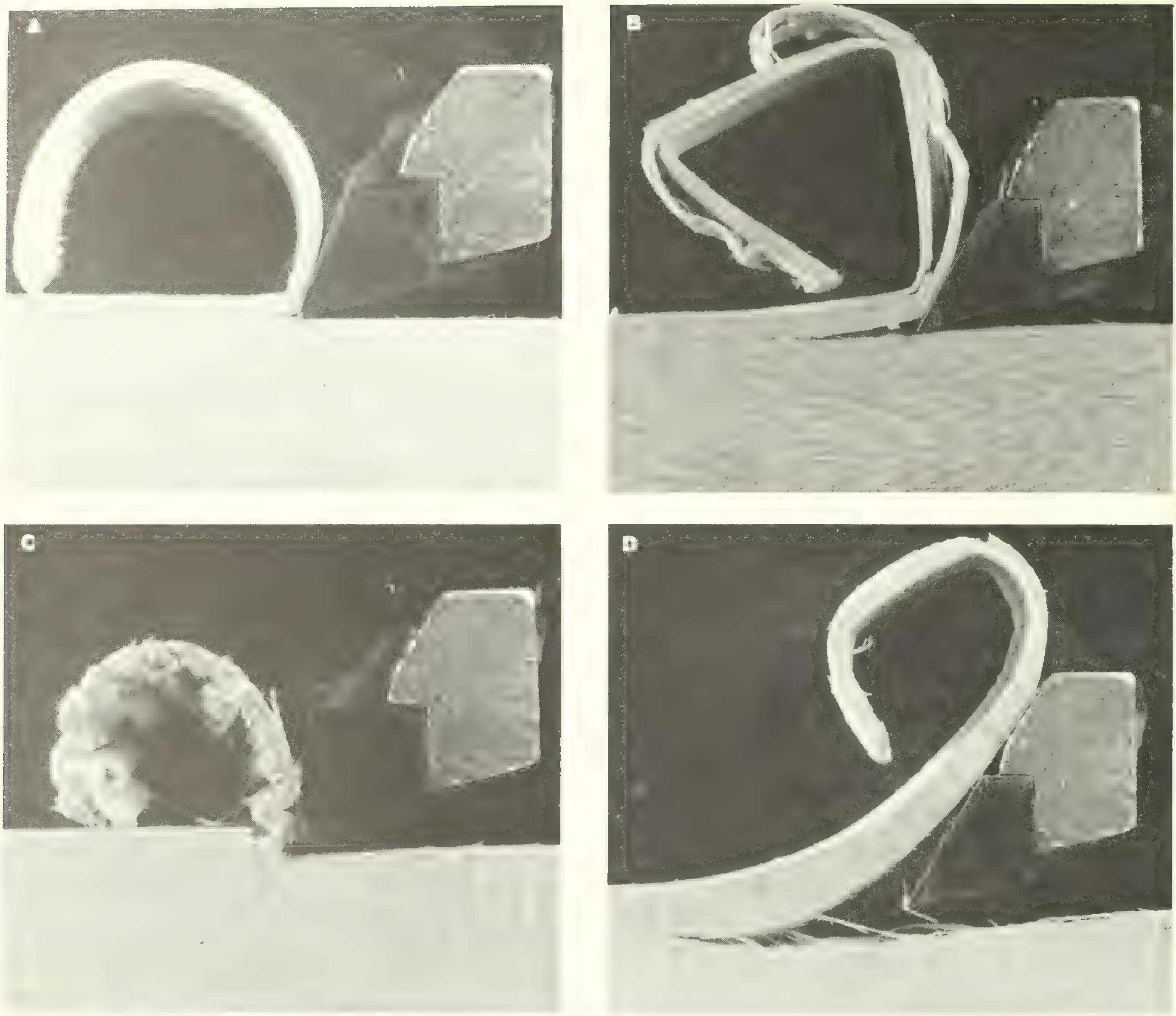
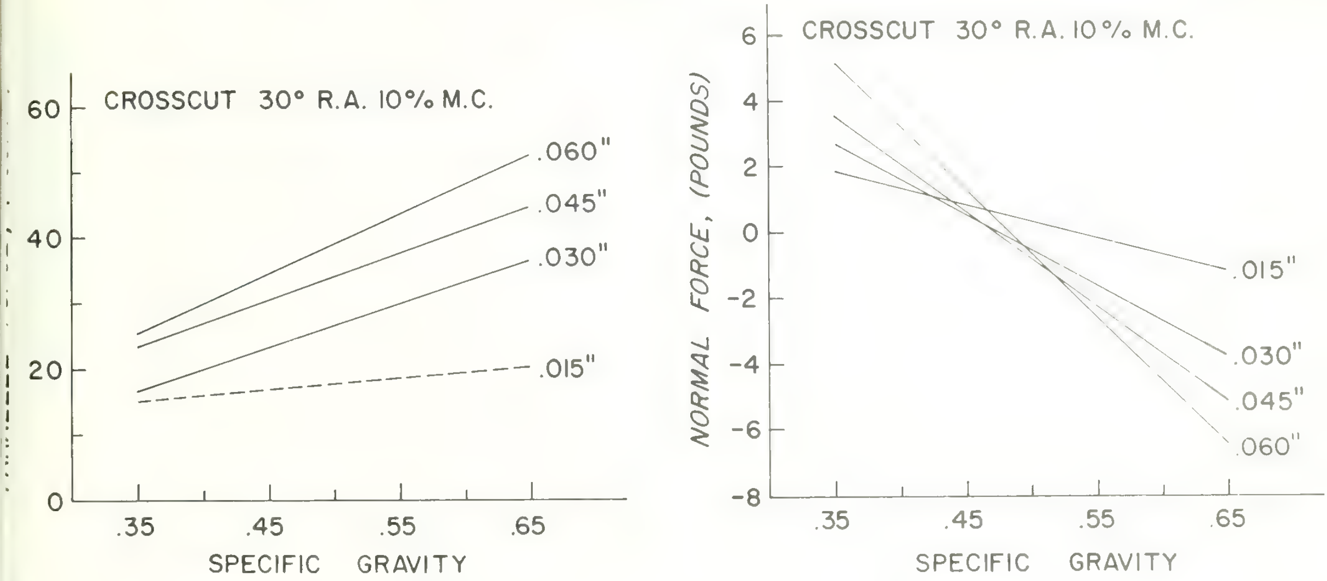


Figure 8.—*Typical chip types resulting from orthogonal cutting in the planing direction. A. Continuous chip formed when making a .045-inch cut in black tupelo at 10.9-percent moisture content with a 20° rake angle and 15° clearance angle. B. Broken chips formed when making a .060-inch cut in winged elm at 10.9-percent moisture content with a 30° rake angle and 15° clearance angle. C. Crushing ahead of the knife produced when making a .060-inch cut in black tupelo at 10.9-percent moisture content with a 10° rake angle and 15° clearance angle. D. Tearing ahead of the knife produced when making a .030-inch cut in black tupelo with interlocked grain at 10.9-percent moisture content with a 30° rake angle and 15° clearance angle.*

Table 5.—*Tool forces when orthogonally cutting in the planing direction with various depths of cut, moisture contents, and rake angles. Values are averaged over all other variables.*

Principal factor	Parallel force Average	Parallel force Maximum	Normal force Average	Normal force Maximum	Normal force Minimum
Depth of cut, inches			*Pounds/0.1 inch*		
.015	9.9	12.0	1.7	2.3	1.0
.030	18.5	23.1	2.5	3.5	1.5
.045	24.2	31.4	3.1	4.4	1.7
.060	30.0	40.1	3.8	5.4	2.0
Moisture content, percent					
10.9	28.2	38.4	4.0	5.5	2.2
18.9	20.0	24.5	2.6	3.5	1.5
104.3	13.8	17.1	1.8	2.6	1.0
Rake angle, degrees					
10	26.3	33.2	6.7	8.6	4.6
20	23.1	27.0	2.3	2.9	1.6
30	12.5	19.8	−.6	.2	-1.5



Depth of cut	Average parallel force y-intercept	Average parallel force Slope	Average parallel force r	Average normal force y-intercept	Average normal force Slope	Average normal force r
---*inch*---						
.015	9.46	16.32	.50	5.57	−10.45	.88
.030	−6.04	65.40	.90	10.35	−21.72	.91
.045	−1.34	70.93	.79	13.80	−29.13	.90
.060	−7.13	92.16	.82	18.81	−38.77	.88

Figure 9.—*Relationship of average parallel and normal cutting force per 0.1-inch knife length with specific gravity (ovendry weight and green volume) for crosscutting dry wood (10 percent moisture content) of 22 species with a 30° rake angle (15° clearance angle) at four depths of cut. Dotted line indicates regression significant at .05 level; others significant at .01 level.*

Table 6. – *Tool forces when orthogonally cutting in the crosscutting direction with various depths of cut, moisture contents, and rake angles. Values are averaged over all other variables.*

Principal factor	Parallel force		Normal force		
	Average	Maximum	Average	Maximum	Minimum
	Pounds/0.1 inch				
Depth of cut, inches					
.015	14.1	17.5	−0.4	0.8	−1.3
.030	23.5	28.6	−1.5	.4	−3.0
.045	29.9	36.5	−2.3	.3	−4.5
.060	35.7	44.2	−3.1	.5	−6.0
Moisture content, percent					
10.9	32.5	41.1	−1.6	1.9	−4.4
18.9	25.5	30.8	−1.9	.1	−3.6
104.3	19.4	23.2	−1.9	−.5	−3.1
Rake angle, degrees					
20	31.5	38.3	1.9	4.1	0.1
30	25.6	31.4	−2.2	.1	−4.1
40	20.2	25.3	−5.1	−2.6	−7.1

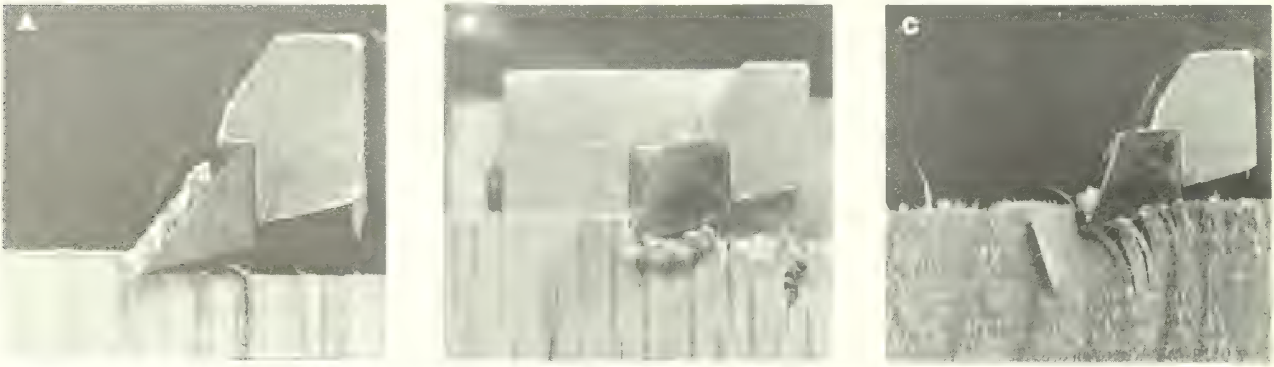


Figure 10. – *Typical chip types resulting from orthogonal cutting in the crosscutting direction (90-90). A. Uniform chips and smooth surfaces formed when making a .030-inch cut in black oak at 10.7 percent moisture content with a 40° rake angle and 15° clearance angle. B. Broken chips and rough surfaces formed when making a .060-inch cut in cherrybark oak at 9.9 percent moisture content with a 20° rake angle and 15° clearance angle. C. Undersized chips formed when making a .045-inch cut in saturated sweetbay with a 20° rake angle and 15° clearance angle.*

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APPENDIX

TABLE OF CONTENTS

Common name	Table number[1]
Ash, green	1 ABC
Ash, white	2 ABC
Elm, American	3 ABC
Elm, winged	4 ABC
Hackberry	5 ABC
Hickory	6 ABC
Maple, red	7 ABC
Oak, black	8 ABC
Oak, blackjack	9 ABC
Oak, cherrybark	10 ABC
Oak, laurel	11 ABC
Oak, northern red	12 ABC
Oak, post	13 ABC
Oak, scarlet	14 ABC
Oak, Shumard	15 ABC
Oak, southern red	16 ABC
Oak, water	17 ABC
Oak, white	18 ABC
Sweetbay	19 ABC
Sweetgum	20 ABC
Tupelo, black	21 ABC
Yellow-poplar	22 ABC

[1] A indicates veneer direction (0-90); B indicates planing direction (90-0); C indicates crosscut direction (90-90).

TABLE 1A.--TOOL FORCES WHEN ORTHOGONALLY CUTTING GREEN ASH VENEER IN THE 0-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	50	60	70
	Pounds per 0.1 inch of knife		
	PARALLEL FORCE[2]		
0.015 inch			
11.0	2.9 (6.8)	3.4 (7.1)	3.3 (5.8)
19.1	2.7 (4.6)	2.5 (5.0)	4.6 (9.6)
109.4	1.6 (3.2)	1.7 (2.7)	3.9 (6.9)
0.030 inch			
11.0	4.1 (10.7)	4.3 (9.2)	3.7 (7.0)
19.1	3.6 (7.5)	3.4 (7.7)	3.1 (5.3)
109.4	2.4 (5.2)	2.3 (4.1)	2.1 (3.0)
0.045 inch			
11.0	4.6 (13.5)	4.6 (11.2)	4.1 (9.0)
19.1	4.5 (8.7)	4.6 (9.8)	3.8 (7.2)
109.4	2.9 (6.8)	2.9 (5.7)	2.4 (4.1)
0.060 inch			
11.0	5.9 (15.7)	5.2 (12.5)	5.8 (11.4)
19.1	5.5 (11.0)	4.6 (10.5)	4.7 (8.7)
109.4	3.4 (7.4)	3.5 (7.0)	3.0 (5.2)
	NORMAL FORCE[3,4]		
0.015 inch			
11.0	0.3 (-0.8 to 1.9)	0.4 (-0.7 to 1.6)	-0.1 (-1.2 to 1.0)
19.1	-.2 (-.8 to .6)	-.1 (-.9 to .9)	.0 (-1.5 to 1.3)
109.4	-.2 (-.6 to .2)	-.2 (-.6 to .2)	-.2 (-1.4 to .8)
0.030 inch			
11.0	.0 (-1.3 to 1.5)	-.2 (-1.6 to .8)	.3 (-1.0 to 1.5)
19.1	-.6 (-1.5 to .1)	-.7 (-2.0 to .3)	.0 (-.9 to 1.1)
109.4	-.4 (-1.2 to .1)	-.6 (-1.3 to .2)	-.2 (-.6 to .3)
0.045 inch			
11.0	-.1 (-1.5 to 1.4)	-.2 (-1.9 to .9)	.2 (-1.6 to 1.6)
19.1	-.7 (-1.8 to .4)	-1.1 (-2.9 to .3)	-.3 (-1.4 to .8)
109.4	-.5 (-1.5 to .1)	-.9 (-1.8 to .3)	-.7 (-1.5 to .0)
0.060 inch			
11.0	-.1 (-1.8 to 1.6)	-.4 (-2.2 to .9)	-.2 (-1.9 to 1.4)
19.1	-.9 (-2.4 to .3)	-1.0 (-2.7 to .2)	-.5 (-2.0 to .9)
109.4	-.6 (-1.9 to .3)	-.9 (-2.2 to .3)	-.8 (-1.9 to .1)

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[1] Clearance angle 0°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 1B.--TOOL FORCES WHEN ORTHOGONALLY CUTTING GREEN ASH PARALLEL TO THE GRAIN IN THE 90-0 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	10	20	30
	Pounds per 0.1 inch of knife		
PARALLEL FORCE[2]			
0.015 inch			
10.7	17.7 (21.7)	16.8 (18.6)	10.7 (14.2)
18.8	11.6 (14.6)	9.5 (10.6)	5.9 (8.2)
100.7	8.4 (9.2)	7.1 (7.9)	4.5 (5.4)
0.030 inch			
10.7	32.4 (41.1)	34.7 (39.0)	12.1 (29.5)
18.8	21.9 (25.7)	20.3 (22.8)	12.7 (17.2)
100.7	15.6 (17.4)	13.2 (15.1)	8.0 (9.8)
0.045 inch			
10.7	43.2 (54.5)	43.4 (48.1)	15.4 (38.3)
18.8	30.2 (36.5)	26.8 (29.3)	17.4 (23.2)
100.7	21.3 (25.0)	18.5 (21.6)	11.1 (13.7)
0.060 inch			
10.7	57.0 (72.7)	57.4 (63.2)	16.2 (48.8)
18.8	38.1 (46.4)	34.7 (38.8)	18.1 (28.1)
100.7	28.0 (33.8)	23.1 (26.9)	12.5 (16.6)
NORMAL FORCE[3,4]			
0.015 inch			
10.7	5.3 (3.9 to 6.5)	2.2 (1.8 to 2.7)	-0.3 (-0.7 to 0.1)
18.8	3.4 (2.4 to 4.3)	1.4 (1.1 to 1.8)	.0 (-.4 to .7)
100.7	2.5 (2.1 to 2.9)	.9 (.7 to 1.3)	.2 (-.2 to .6)
0.030 inch			
10.7	8.8 (6.3 to 11.2)	4.3 (3.8 to 4.8)	-.5 (-1.6 to .6)
18.8	5.9 (4.3 to 7.1)	2.3 (1.6 to 2.7)	-.6 (-1.2 to .2)
100.7	3.7 (3.2 to 4.2)	1.2 (.7 to 1.7)	-.3 (-.8 to .1)
0.045 inch			
10.7	11.3 (7.1 to 14.3)	5.5 (4.7 to 6.1)	-1.1 (-3.1 to .2)
18.8	8.0 (6.3 to 9.5)	2.7 (2.3 to 3.2)	-.9 (-1.8 to -.3)
100.7	4.8 (3.8 to 5.6)	1.2 (.6 to 1.7)	-.9 (-1.4 to -.1)
0.060 inch			
10.7	15.2 (10.3 to 18.5)	6.8 (6.0 to 7.7)	-.8 (-3.2 to 1.0)
18.8	9.7 (7.7 to 12.1)	3.6 (2.8 to 4.1)	-1.1 (-2.2 to -.3)
100.7	5.9 (4.6 to 6.8)	1.1 (.5 to 1.7)	-.8 (-1.8 to -.2)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 1C.--TOOL FORCES WHEN ORTHOGONALLY CUTTING GREEN ASH ACROSS THE GRAIN IN THE 90-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	20	30	40
	Pounds per 0.1 inch of knife		
		PARALLEL FORCE[2]	
0.015 inch			
10.5	23.4 (28.5)	18.7 (22.4)	15.2 (17.5)
18.4	16.6 (19.5)	13.7 (16.8)	11.5 (13.9)
111.7	12.7 (15.1)	10.8 (12.2)	8.6 (10.3)
0.030 inch			
10.5	35.9 (45.0)	32.4 (39.5)	25.3 (29.7)
18.4	30.3 (35.4)	22.3 (26.4)	18.3 (22.0)
111.7	21.2 (23.7)	16.2 (18.4)	12.2 (14.7)
0.045 inch			
10.5	45.7 (56.6)	46.5 (57.9)	34.0 (39.3)
18.4	37.2 (42.3)	30.2 (35.8)	24.2 (28.7)
111.7	28.3 (33.1)	21.2 (24.5)	16.5 (20.6)
0.060 inch			
10.5	44.5 (59.1)	54.6 (66.8)	38.4 (46.4)
18.4	45.5 (53.5)	36.4 (43.6)	28.7 (34.7)
111.7	30.2 (35.7)	25.4 (29.2)	20.5 (25.2)
		NORMAL FORCE[3,4]	
0.015 inch			
10.5	2.5 (1.8 to 4.5)	0.2 (-0.9 to 2.2)	-2.5 (-3.4 to -1.1)
18.4	1.9 (1.1 to 3.3)	-.2 (-1.1 to .7)	-1.6 (-2.6 to -.6)
111.7	.6 (-.1 to 1.2)	-.5 (-1.2 to .1)	-1.8 (-2.4 to -1.1)
0.030 inch			
10.5	4.1 (2.5 to 7.1)	-1.3 (-3.2 to 1.3)	-5.5 (-7.2 to -2.3)
18.4	2.4 (1.2 to 4.3)	-1.7 (-2.8 to -.2)	-4.0 (-5.1 to -2.0)
111.7	.5 (-.1 to 1.2)	-1.8 (-2.6 to -.9)	-3.6 (-4.8 to -2.2)
0.045 inch			
10.5	5.4 (2.5 to 8.4)	-1.9 (-4.7 to 3.1)	-7.9 (-10.0 to -3.5)
18.4	2.5 (1.0 to 4.3)	-3.0 (-4.7 to -.4)	-5.9 (-8.0 to -3.0)
111.7	.5 (-.6 to 1.5)	-2.8 (-3.9 to -1.7)	-5.1 (-6.8 to -3.1)
0.060 inch			
10.5	6.3 (2.1 to 10.3)	.9 (-6.5 to 11.9)	-9.1 (-11.8 to -5.1)
18.4	2.6 (.8 to 5.6)	-3.8 (-6.3 to -.4)	-7.3 (-9.7 to -4.3)
111.7	.6 (-.8 to 2.3)	-3.7 (-4.9 to -2.5)	-6.4 (-8.3 to -4.1)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 2A.--TOOL FORCES WHEN ORTHOGONALLY CUTTING WHITE ASH VENEER IN THE 0-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	50	60	70
	Pounds per 0.1 inch of knife		
	PARALLEL FORCE[2]		
0.015 inch			
11.2	3.7 (7.4)	3.7 (6.7)	4.2 (7.5)
19.1	2.9 (5.5)	2.5 (4.7)	5.0 (11.5)
106.0	2.1 (3.6)	2.0 (3.1)	4.7 (8.0)
0.030 inch			
11.2	4.8 (12.9)	4.8 (10.4)	4.7 (7.9)
19.1	4.5 (8.9)	4.6 (8.2)	3.3 (5.7)
106.0	2.9 (6.0)	2.8 (4.5)	2.2 (3.8)
0.045 inch			
11.2	5.8 (15.0)	5.8 (13.9)	5.8 (10.9)
19.1	4.7 (10.9)	5.3 (10.2)	4.4 (7.8)
106.0	3.5 (7.3)	3.4 (5.9)	2.8 (4.7)
0.060 inch			
11.2	6.5 (15.8)	6.6 (15.6)	6.8 (13.9)
19.1	5.9 (13.0)	5.9 (10.4)	5.5 (11.0)
106.0	4.1 (8.2)	4.1 (7.3)	3.3 (5.5)
	NORMAL FORCE[3,4]		
0.015 inch			
11.2	-0.1 (-1.0 to 1.2)	0.2 (-1.1 to 1.2)	0.1 (-2.2 to 1.4)
19.1	-.2 (-.9 to 1.0)	-.2 (-1.0 to .6)	.3 (-1.2 to 2.5)
106.0	-.2 (-.6 to .4)	-.3 (-.8 to .2)	-.3 (-1.4 to .7)
0.030 inch			
11.2	-.2 (-1.8 to 1.6)	-.1 (-1.4 to 1.3)	.7 (-1.3 to 2.2)
19.1	-.7 (-1.8 to .1)	-1.1 (-2.5 to .2)	-.4 (-1.2 to .9)
106.0	-.4 (-1.2 to .5)	-.8 (-1.8 to .1)	.3 (-.2 to 1.1)
0.045 inch			
11.2	-.1 (-1.9 to 1.5)	-.1 (-1.9 to 1.8)	.4 (-1.0 to 2.4)
19.1	-.7 (-2.0 to .8)	-1.1 (-3.2 to .2)	-.9 (-2.2 to .6)
106.0	-.6 (-1.6 to .3)	-1.1 (-2.5 to .1)	-.2 (-1.1 to .6)
0.060 inch			
11.2	.0 (-2.7 to 1.8)	.0 (-1.8 to 1.7)	.6 (-1.1 to 2.8)
19.1	-1.0 (-2.4 to .3)	-1.4 (-3.3 to .1)	-1.0 (-2.4 to 1.3)
106.0	-.7 (-1.6 to .2)	-1.1 (-2.7 to .2)	-.3 (-1.5 to .6)

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[1] Clearance angle 0°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 2B.--TOOL FORCES WHEN ORTHOGONALLY CUTTING WHITE ASH PARALLEL TO THE GRAIN IN THE 90-0 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	10	20	30
	Pounds per 0.1 inch of knife		
		PARALLEL FORCE[2]	
0.015 inch			
11.0	17.3 (21.9)	14.3 (15.8)	9.7 (12.8)
19.2	12.3 (14.2)	8.5 (9.9)	7.0 (8.0)
98.5	7.5 (8.7)	6.2 (7.4)	4.4 (5.1)
0.030 inch			
11.0	29.3 (39.6)	25.6 (28.3)	18.3 (23.6)
19.2	22.6 (26.7)	17.2 (19.6)	13.1 (14.4)
98.5	14.1 (16.4)	11.0 (13.1)	8.0 (9.0)
0.045 inch			
11.0	40.0 (52.7)	37.5 (41.3)	21.9 (32.3)
19.2	28.4 (37.2)	23.1 (26.2)	17.0 (18.9)
98.5	20.8 (25.8)	16.5 (18.1)	10.5 (11.7)
0.060 inch			
11.0	49.0 (64.5)	53.3 (58.3)	22.1 (37.8)
19.2	34.3 (45.1)	32.7 (36.4)	21.0 (24.0)
98.5	26.3 (32.8)	21.8 (24.7)	11.3 (13.6)
		NORMAL FORCE[3,4]	
0.015 inch			
11.0	5.0 (3.7 to 6.6)	1.9 (1.5 to 2.3)	-0.1 (-0.4 to 0.4)
19.2	3.4 (2.8 to 4.1)	1.1 (.8 to 1.6)	-.1 (-.4 to .3)
98.5	2.3 (1.8 to 2.9)	.9 (.6 to 1.2)	.1 (-.1 to .4)
0.030 inch			
11.0	8.4 (3.9 to 10.8)	3.2 (2.8 to 3.8)	-.7 (-1.4 to .0)
19.2	5.8 (3.9 to 7.1)	2.0 (1.5 to 2.5)	-.6 (-1.0 to -.2)
98.5	3.5 (2.6 to 4.4)	.9 (.5 to 1.4)	-.3 (-.7 to .2)
0.045 inch			
11.0	11.4 (6.4 to 14.3)	4.4 (3.9 to 5.1)	-1.0 (-2.0 to .0)
19.2	7.3 (4.8 to 9.6)	2.5 (2.0 to 3.0)	-1.0 (-1.4 to -.3)
98.5	4.8 (3.8 to 6.1)	1.0 (.6 to 1.5)	-.6 (-1.1 to -.2)
0.060 inch			
11.0	12.8 (7.9 to 16.7)	5.8 (4.8 to 6.7)	-1.1 (-2.6 to .3)
19.2	8.7 (5.6 to 10.6)	3.4 (2.7 to 3.9)	-1.1 (-1.4 to -.5)
98.5	5.5 (3.6 to 7.2)	.8 (.3 to 1.4)	-1.2 (-1.7 to -.6)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 2C.--TOOL FORCES WHEN ORTHOGONALLY CUTTING WHITE ASH ACROSS THE GRAIN IN THE 90-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees 20	30	40
	Pounds per 0.1 inch of knife		
	PARALLEL FORCE[2]		
0.015 inch			
10.8	19.9 (24.0)	22.6 (26.2)	17.1 (20.6)
18.3	22.3 (25.0)	12.6 (14.4)	11.2 (13.2)
106.2	13.5 (15.3)	9.9 (11.7)	9.1 (10.5)
0.030 inch			
10.8	42.1 (49.2)	33.7 (39.2)	27.2 (31.5)
18.3	33.8 (37.8)	23.2 (26.6)	20.3 (23.2)
106.2	21.2 (23.8)	15.6 (17.8)	13.7 (15.3)
0.045 inch			
10.8	51.3 (60.7)	44.8 (50.7)	35.0 (43.4)
18.3	41.8 (46.9)	31.1 (35.2)	24.7 (28.0)
106.2	27.5 (31.5)	20.5 (23.3)	17.4 (20.3)
0.060 inch			
10.8	62.7 (76.2)	51.2 (60.2)	41.8 (49.7)
18.3	49.4 (57.8)	38.1 (43.6)	30.3 (35.8)
106.2	35.5 (41.3)	25.0 (28.2)	21.7 (24.6)
	NORMAL FORCE[3,4]		
0.015 inch			
10.8	2.3 (1.3 to 3.6)	-0.8 (-1.9 to 0.4)	-3.2 (-4.4 to -1.9)
18.3	1.6 (1.0 to 2.5)	-.3 (-1.0 to .3)	-2.0 (-2.6 to -1.2)
106.2	.4 (.0 to 1.0)	-.7 (-1.3 to -.2)	-1.8 (-2.3 to -1.2)
0.030 inch			
10.8	3.1 (1.7 to 4.9)	-2.3 (-3.8 to -.4)	-6.1 (-8.2 to -4.2)
18.3	1.5 (.7 to 3.0)	-2.3 (-3.4 to -1.3)	-4.6 (-5.9 to -2.9)
106.2	.2 (-.5 to .8)	-2.1 (-2.9 to -1.3)	-3.8 (-4.8 to -2.7)
0.045 inch			
10.8	4.1 (1.5 to 6.1)	-3.8 (-6.1 to -1.1)	-9.1 (-11.8 to -6.3)
18.3	1.6 (.1 to 3.5)	-3.7 (-5.1 to -2.0)	-6.8 (-8.2 to -4.2)
106.2	-.1 (-.9 to 1.0)	-3.3 (-4.4 to -2.2)	-5.3 (-6.6 to -4.0)
0.060 inch			
10.8	4.8 (1.6 to 8.0)	-4.4 (-7.7 to -.7)	-11.3 (-14.0 to -7.9)
18.3	1.9 (-.2 to 4.1)	-5.1 (-7.5 to -2.8)	-8.5 (-11.5 to -4.9)
106.2	-.2 (-1.4 to 1.1)	-4.3 (-5.5 to -2.9)	-6.9 (-8.7 to -5.2)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 3A.--TOOL FORCES WHEN ORTHOGONALLY CUTTING AMERICAN ELM VENEER IN THE 0-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	50	60	70
	Pounds per 0.1 inch of knife		
		PARALLEL FORCE[2]	
0.015 inch			
11.7	2.7 (5.5)	2.9 (5.0)	2.8 (4.5)
18.9	2.2 (4.4)	2.0 (3.3)	3.6 (7.4)
108.0	1.8 (2.9)	1.5 (2.5)	3.3 (5.3)
0.030 inch			
11.7	4.0 (8.5)	3.8 (7.5)	3.3 (5.6)
18.9	3.3 (6.4)	3.0 (5.5)	2.5 (4.2)
108.0	2.7 (4.8)	2.2 (3.6)	2.1 (3.1)
0.045 inch			
11.7	4.9 (10.7)	4.8 (9.1)	3.7 (7.1)
18.9	4.3 (8.8)	3.8 (7.0)	3.3 (5.3)
108.0	3.1 (5.8)	3.0 (4.8)	2.7 (4.1)
0.060 inch			
11.7	5.8 (12.1)	5.1 (11.1)	4.4 (8.1)
18.9	5.2 (10.0)	4.3 (8.4)	3.8 (6.5)
108.0	3.6 (7.0)	3.5 (5.8)	3.0 (4.8)
		NORMAL FORCE[3,4]	
0.015 inch			
11.7	0.1 (-0.6 to .6)	0.4 (-0.4 to 1.1)	-0.2 (-1.0 to 0.6)
18.9	-.2 (-.8 to .7)	-.3 (-.8 to .2)	-.4 (-1.8 to .9)
108.0	-.2 (-.5 to .2)	-.3 (-.6 to .2)	-.4 (-1.6 to .7)
0.030 inch			
11.7	-.2 (-1.3 to .6)	-.1 (-1.3 to .8)	.3 (-.6 to 1.2)
18.9	-.5 (-1.5 to .8)	-.9 (-1.8 to .1)	-.2 (-.8 to .6)
108.0	-.5 (-1.1 to .2)	-.7 (-1.3 to .0)	.1 (-.4 to .6)
0.045 inch			
11.7	-.5 (-1.9 to .8)	-.3 (-1.8 to 1.2)	-.2 (-1.6 to .9)
18.9	-.7 (-2.1 to .9)	-1.2 (-2.7 to .2)	-.7 (-1.7 to .3)
108.0	-.7 (-1.6 to .3)	-.9 (-1.8 to -.1)	-.5 (-1.1 to .3)
0.060 inch			
11.7	-.7 (-2.5 to 1.1)	-.6 (-2.6 to 1.2)	-.4 (-1.9 to .9)
18.9	-.9 (-2.4 to .5)	-1.4 (-3.1 to .1)	-1.0 (-2.2 to .4)
108.0	-.9 (-2.2 to .2)	-1.2 (-2.5 to -.2)	-.8 (-1.9 to .3)

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[1] Clearance angle 0°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 3B.--TOOL FORCES WHEN ORTHOGONALLY CUTTING AMERICAN ELM PARALLEL TO THE GRAIN IN THE 90-0 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	10	20	30
	Pounds per 0.1 inch of knife		
	PARALLEL FORCE[2]		
0.015 inch			
10.8	15.8 (18.7)	14.9 (17.1)	9.3 (12.0)
18.8	12.0 (13.6)	9.2 (10.2)	6.7 (8.7)
102.8	8.7 (10.4)	7.5 (8.0)	5.0 (6.1)
0.030 inch			
10.8	30.3 (38.2)	31.0 (35.0)	11.9 (21.1)
18.8	22.5 (27.9)	19.1 (21.4)	13.5 (17.5)
102.8	14.1 (17.2)	14.1 (15.9)	8.0 (9.6)
0.045 inch			
10.8	40.5 (50.8)	38.7 (46.6)	13.0 (35.1)
18.8	30.7 (37.7)	26.4 (30.5)	14.7 (23.7)
102.8	25.4 (31.9)	19.6 (22.9)	10.7 (15.8)
0.060 inch			
10.8	50.1 (64.6)	50.6 (60.4)	13.9 (43.3)
18.8	37.7 (46.3)	33.4 (37.6)	16.4 (32.3)
102.8	30.0 (38.5)	23.0 (27.4)	12.7 (18.6)
	NORMAL FORCE[3,4]		
0.015 inch			
10.8	4.6 (3.8 to 5.2)	1.8 (1.5 to 2.1)	-0.2 (-0.5 to 0.2)
18.8	3.5 (2.7 to 4.0)	1.3 (.9 to 1.6)	-.2 (-.5 to .4)
102.8	2.6 (2.0 to 3.2)	.8 (.6 to 1.1)	-.1 (-.4 to .2)
0.030 inch			
10.8	8.2 (6.0 to 9.7)	3.6 (3.0 to 4.0)	-.6 (-1.5 to .1)
18.8	5.9 (3.8 to 7.3)	2.0 (1.6 to 2.4)	-1.0 (-1.3 to -.5)
102.8	4.1 (3.3 to 5.0)	1.1 (.8 to 1.5)	-.5 (-.8 to -.1)
0.045 inch			
10.8	10.5 (7.5 to 12.8)	3.8 (2.7 to 4.6)	-.6 (-2.4 to .2)
18.8	7.6 (5.0 to 9.4)	2.5 (2.0 to 2.9)	-1.2 (-2.0 to -.1)
102.8	5.7 (4.6 to 6.9)	1.2 (.8 to 1.7)	-.8 (-1.6 to -.2)
0.060 inch			
10.8	12.7 (8.9 to 16.5)	4.9 (3.6 to 6.0)	-.8 (-3.1 to .0)
18.8	9.2 (6.1 to 11.4)	2.9 (2.3 to 3.5)	-1.3 (-2.7 to -.3)
102.8	6.8 (5.0 to 8.4)	1.2 (.6 to 1.7)	-1.1 (-2.1 to -.3)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 3C.--TOOL FORCES WHEN ORTHOGONALLY CUTTING AMERICAN ELM ACROSS THE GRAIN IN THE 90-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	20	30	40
	Pounds per 0.1 inch of knife		
		PARALLEL FORCE[2]	
0.015 inch			
10.4	20.1 (25.0)	18.9 (23.0)	13.8 (18.3)
18.4	17.2 (19.3)	13.2 (15.4)	11.0 (13.3)
107.9	12.0 (14.0)	10.4 (11.8)	7.8 (9.0)
0.030 inch			
10.4	38.3 (44.0)	30.5 (35.3)	23.1 (28.7)
18.4	30.1 (33.0)	22.9 (26.4)	17.3 (21.1)
107.9	22.3 (25.1)	17.1 (19.5)	12.6 (14.6)
0.045 inch			
10.4	42.9 (50.0)	38.0 (44.6)	30.6 (36.6)
18.4	38.5 (43.4)	29.1 (33.2)	22.7 (26.6)
107.9	30.4 (33.3)	21.8 (24.0)	15.3 (18.7)
0.060 inch			
10.4	51.3 (60.5)	42.0 (51.5)	35.5 (43.7)
18.4	48.4 (54.8)	35.5 (39.7)	28.0 (36.0)
107.9	38.2 (42.9)	26.7 (30.7)	19.4 (22.5)
		NORMAL FORCE[3,4]	
0.015 inch			
10.4	1.7 (0.8 to 2.3)	-0.6 (-1.8 to 0.8)	-2.6 (-3.8 to -1.6)
18.4	1.5 (1.0 to 1.8)	-.7 (-1.2 to -.1)	-1.6 (-2.5 to -1.1)
107.9	.6 (.3 to .9)	-.5 (-.9 to -.1)	-1.7 (-2.4 to -.9)
0.030 inch			
10.4	2.3 (1.0 to 4.3)	-2.3 (-3.9 to -.2)	-5.3 (-7.3 to -3.7)
18.4	1.6 (1.0 to 2.8)	-2.0 (-3.2 to -1.1)	-4.1 (-5.9 to -3.2)
107.9	.5 (-.1 to 1.0)	-1.7 (-2.6 to -.9)	-3.6 (-4.4 to -2.7)
0.045 inch			
10.4	3.0 (.1 to 4.7)	-3.1 (-5.3 to -.3)	-7.6 (-10.2 to -5.1)
18.4	1.8 (.8 to 3.6)	-3.0 (-4.3 to -1.9)	-6.2 (-7.9 to -4.3)
107.9	.6 (-.3 to 1.4)	-2.6 (-3.7 to -1.6)	-4.9 (-6.8 to -3.7)
0.060 inch			
10.4	3.9 (1.1 to 6.7)	-3.6 (-6.9 to -1.3)	-9.8 (-13.1 to -6.5)
18.4	2.3 (.8 to 4.4)	-4.4 (-5.9 to -2.6)	-7.8 (-10.6 to -3.9)
107.9	.9 (-.5 to 2.0)	-3.4 (-4.9 to -2.2)	-6.6 (-8.0 to -4.7)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five)

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece

TABLE 4A.--TOOL FORCES WHEN ORTHOGONALLY CUTTING WINGED ELM VENEER IN THE 0-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	50	60	70
	Pounds per 0.1 inch of knife		
PARALLEL FORCE[2]			
0.015 inch			
11.6	3.2 (6.3)	3.9 (6.2)	3.3 (5.4)
19.1	2.6 (4.5)	2.7 (4.4)	5.3 (10.0)
88.8	2.2 (3.6)	2.3 (3.3)	4.4 (8.6)
0.030 inch			
11.6	5.3 (10.3)	5.4 (9.8)	4.3 (6.6)
19.1	4.1 (8.0)	3.9 (6.2)	3.3 (5.6)
88.8	3.3 (6.7)	3.3 (5.3)	2.6 (3.9)
0.045 inch			
11.6	6.8 (13.8)	6.5 (11.9)	5.0 (9.1)
19.1	5.2 (10.4)	4.7 (9.0)	4.4 (7.2)
88.8	4.3 (9.0)	3.8 (6.8)	3.1 (5.3)
0.060 inch			
11.6	7.5 (16.2)	7.0 (15.2)	5.9 (11.3)
19.1	6.1 (13.8)	5.8 (10.5)	5.2 (9.3)
88.8	5.0 (10.8)	4.4 (9.1)	3.8 (6.5)
NORMAL FORCE[3,4]			
0.015 inch			
11.6	-0.3 (-0.9 to .5)	0.7 (0.2 to 1.4)	0.0 (-1.0 to 1.1)
19.1	-.5 (-1.0 to .1)	-.7 (-1.1 to .1)	-.5 (-2.0 to 1.2)
88.8	-.3 (-.7 to .2)	-.2 (-.6 to .3)	-.9 (-2.2 to .7)
0.030 inch			
11.6	-.7 (-1.9 to .6)	-.3 (-1.6 to 1.2)	.1 (-.8 to 1.2)
19.1	-.9 (-1.9 to .1)	-1.3 (-2.3 to -.2)	-.4 (-1.2 to .8)
88.8	-.7 (-1.7 to .5)	-1.0 (-1.9 to .0)	-.1 (-.8 to .4)
0.045 inch			
11.6	-.8 (-2.8 to .8)	-.7 (-2.4 to .9)	-.7 (-2.0 to .7)
19.1	-1.0 (-2.5 to .5)	-1.5 (-2.9 to .2)	-1.3 (-2.2 to .3)
88.8	-.8 (-2.4 to .7)	-1.1 (-2.7 to .1)	-.9 (-1.7 to .0)
0.060 inch			
11.6	-.9 (-3.2 to 1.2)	-.6 (-2.6 to 1.2)	-.6 (-2.4 to .6)
19.1	-1.3 (-3.2 to .5)	-1.7 (-3.5 to .1)	-1.4 (-2.8 to .5)
88.8	-.9 (-2.8 to .6)	-1.2 (-3.0 to .6)	-1.2 (-2.5 to .3)

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[1] Clearance angle 0°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 4B.--TOOL FORCES WHEN ORTHOGONALLY CUTTING WINGED ELM PARALLEL TO THE GRAIN IN THE 90-0 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	10	20	30
	----Pounds per 0.1 inch of knife----		
	PARALLEL FORCE[2]		
0.015 inch			
10.9	15.5 (18.9)	13.7 (15.7)	8.4 (10.9)
19.2	13.0 (15.3)	9.4 (10.4)	6.2 (7.8)
87.7	9.7 (11.1)	7.2 (8.8)	4.8 (6.7)
0.030 inch			
10.9	33.0 (41.8)	30.4 (34.7)	14.1 (20.3)
19.2	24.4 (29.0)	20.2 (22.8)	12.6 (15.7)
87.7	15.8 (20.5)	13.2 (18.3)	7.8 (10.5)
0.045 inch			
10.9	39.6 (55.4)	41.0 (46.0)	16.0 (28.5)
19.2	29.8 (38.2)	25.1 (29.3)	16.4 (21.3)
87.7	21.3 (31.5)	15.8 (22.9)	9.5 (13.6)
0.060 inch			
10.9	51.8 (71.3)	50.3 (56.2)	19.7 (34.6)
19.2	36.4 (47.7)	29.2 (35.0)	18.7 (25.4)
87.7	28.6 (40.9)	18.6 (30.6)	12.0 (15.9)
	NORMAL FORCE[3,4]		
0.015 inch			
10.9	4.7 (3.9 to 5.7)	2.0 (1.6 to 2.4)	-0.1 (-0.5 to 0.5)
19.2	3.8 (2.6 to 4.7)	1.2 (1.0 to 1.5)	.1 (-.2 to .4)
87.7	2.6 (2.1 to 3.0)	.8 (.6 to 1.1)	.0 (-.3 to .3)
0.030 inch			
10.9	9.0 (5.9 to 10.8)	3.7 (3.0 to 4.4)	-.5 (-1.3 to .3)
19.2	6.1 (4.8 to 7.1)	1.9 (1.5 to 2.2)	-.5 (-.9 to .1)
87.7	3.9 (2.6 to 5.0)	1.0 (.5 to 1.4)	-.4 (-.8 to .0)
0.045 inch			
10.9	11.1 (6.5 to 14.4)	4.7 (4.1 to 5.3)	-.7 (-2.2 to .1)
19.2	7.6 (5.3 to 9.1)	2.2 (1.9 to 2.6)	-.8 (-1.4 to -.1)
87.7	5.1 (2.8 to 7.3)	1.1 (.5 to 1.9)	-.6 (-1.2 to -.1)
0.060 inch			
10.9	13.9 (7.6 to 18.0)	5.6 (4.6 to 6.4)	-1.1 (-2.7 to .2)
19.2	9.0 (5.7 to 11.0)	2.5 (1.7 to 3.0)	-1.0 (-1.8 to -.1)
87.7	6.2 (3.9 to 8.9)	1.3 (.6 to 1.9)	-.7 (-1.4 to .1)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 4C.--TOOL FORCES WHEN ORTHOGONALLY CUTTING WINGED ELM ACROSS THE GRAIN IN THE 90-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	20	30	40
	Pounds per 0.1 inch of knife		
	PARALLEL FORCE[2]		
0.015 inch			
11.6	22.0 (28.2)	19.7 (23.2)	15.8 (18.6)
18.6	17.4 (20.7)	14.2 (16.9)	11.9 (14.0)
91.2	14.5 (16.7)	10.2 (12.3)	8.3 (9.4)
0.030 inch			
11.6	42.5 (48.8)	35.5 (42.1)	25.6 (30.1)
18.6	34.5 (38.8)	24.9 (28.7)	19.3 (21.2)
91.2	26.2 (28.8)	17.7 (19.8)	14.0 (16.6)
0.045 inch			
11.6	54.3 (60.3)	40.7 (46.9)	34.2 (41.0)
18.6	41.9 (46.9)	32.8 (38.9)	24.8 (28.4)
91.2	35.4 (39.1)	24.6 (28.4)	19.0 (21.7)
0.060 inch			
11.6	60.2 (68.1)	53.7 (62.3)	39.9 (48.4)
18.6	52.6 (61.6)	39.0 (45.4)	29.7 (35.6)
91.2	44.0 (48.8)	30.7 (34.2)	23.3 (27.7)
	NORMAL FORCE[3,4]		
0.015 inch			
11.6	1.6 (0.9 to 2.5)	-1.0 (-2.0 to -0.2)	-3.3 (-4.3 to -2.4)
18.6	1.3 (1.0 to 2.0)	-1.0 (-1.6 to -.4)	-2.4 (-2.9 to -1.7)
91.2	.5 (.1 to 1.0)	-.7 (-1.1 to -.3)	-1.9 (-2.4 to -1.3)
0.030 inch			
11.6	2.0 (.8 to 4.9)	-3.3 (-5.1 to -.7)	-6.7 (-8.3 to -4.2)
18.6	1.3 (.4 to 2.4)	-2.9 (-4.1 to -1.8)	-5.2 (-6.4 to -4.1)
91.2	.3 (-.5 to .9)	-2.4 (-3.3 to -1.7)	-4.3 (-5.1 to -3.5)
0.045 inch			
11.6	2.9 (-.1 to 5.8)	-4.2 (-6.3 to -1.6)	-9.2 (-11.5 to -6.7)
18.6	1.5 (.4 to 2.9)	-4.3 (-6.1 to -2.7)	-7.3 (-9.1 to -5.3)
91.2	.3 (-.9 to 1.2)	-3.6 (-4.5 to -2.4)	-5.6 (-6.9 to -4.3)
0.060 inch			
11.6	3.4 (-.6 to 6.8)	-6.3 (-9.1 to -1.0)	-11.7 (-14.2 to -8.1)
18.6	1.8 (.3 to 3.6)	-5.6 (-7.5 to -3.4)	-9.7 (-12.1 to -5.8)
91.2	.5 (-.8 to 1.8)	-4.7 (-6.0 to -3.5)	-7.5 (-9.4 to -4.6)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five)

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 5A.--TOOL FORCES WHEN ORTHOGONALLY CUTTING HACKBERRY VENEER IN THE 0-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	50	60	70
	Pounds per 0.1 inch of knife		
		PARALLEL FORCE[2]	
0.015 inch			
11.1	2.8 (5.7)	2.8 (4.8)	3.9 (7.0)
19.5	2.3 (3.8)	1.9 (3.3)	3.8 (7.8)
115.0	1.8 (3.0)	1.7 (2.9)	3.7 (5.4)
0.030 inch			
11.1	4.1 (9.5)	3.6 (7.4)	3.6 (6.1)
19.5	3.6 (6.0)	3.5 (5.7)	2.9 (4.2)
115.0	2.7 (5.1)	2.6 (4.4)	2.4 (3.4)
0.045 inch			
11.1	5.8 (12.7)	4.4 (9.4)	4.3 (7.8)
19.5	4.2 (7.9)	4.0 (7.7)	3.6 (5.3)
115.0	3.2 (6.5)	3.3 (5.7)	3.0 (4.3)
0.060 inch			
11.1	5.1 (14.9)	5.3 (11.3)	5.3 (10.4)
19.5	4.8 (9.6)	4.8 (8.6)	4.2 (6.9)
115.0	3.6 (7.6)	3.5 (6.8)	3.4 (5.2)
		NORMAL FORCE[3,4]	
0.015 inch			
11.1	0.1 (-0.6 to 1.3)	0.2 (-0.6 to 1.1)	-0.1 (-1.7 to 1.2)
19.5	-.1 (-.8 to .7)	-.4 (-.9 to .1)	.0 (-1.2 to 1.3)
115.0	-.3 (-.6 to .2)	-.3 (-.6 to .2)	-.7 (-1.5 to .4)
0.030 inch			
11.1	-.1 (-1.4 to 1.3)	-.6 (-1.5 to .9)	.3 (-.7 to 1.2)
19.5	-.7 (-1.3 to .2)	-1.0 (-1.9 to .2)	-.6 (-1.2 to .2)
115.0	-.5 (-1.1 to .1)	-.7 (-1.3 to -.1)	-.1 (-.5 to .6)
0.045 inch			
11.1	-.1 (-1.5 to 2.0)	-.4 (-2.0 to 1.1)	.1 (-1.2 to 1.5)
19.5	-.8 (-1.8 to .4)	-1.1 (-2.5 to .0)	-1.1 (-1.9 to .0)
115.0	-.6 (-1.6 to .2)	-.9 (-2.1 to 1)	-.6 (-1.3 to .2)
0.060 inch			
11.1	-.2 (-2.0 to 1.8)	-.3 (-1.8 to 1.8)	.2 (-1.5 to 1.9)
19.5	-.9 (-2.3 to .3)	-1.3 (-2.9 to .0)	-1.3 (-2.4 to -.1)
115.0	-.6 (-2.1 to .6)	-.8 (-2.2 to .3)	-1.0 (-1.7 to .2)

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[1] Clearance angle 0°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 5B.--TOOL FORCES WHEN ORTHOGONALLY CUTTING HACKBERRY PARALLEL TO THE GRAIN IN THE 90-0 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	10	20	30
	Pounds per 0.1 inch of knife		
	PARALLEL FORCE[2]		
0.015 inch			
10.7	14.6 (18.7)	13.8 (16.2)	8.3 (12.9)
19.6	9.3 (11.9)	7.8 (8.9)	6.2 (7.3)
117.6	8.5 (11.1)	6.2 (7.7)	3.9 (4.8)
0.030 inch			
10.7	30.0 (37.8)	29.5 (34.4)	15.1 (24.7)
19.6	18.7 (25.0)	15.4 (18.6)	11.5 (13.4)
117.6	15.1 (18.4)	11.1 (12.6)	7.0 (8.7)
0.045 inch			
10.7	40.7 (52.3)	37.7 (40.9)	14.2 (33.9)
19.6	24.2 (33.9)	21.8 (24.8)	15.7 (19.1)
117.6	21.2 (26.6)	15.7 (18.6)	9.1 (11.5)
0.060 inch			
10.7	52.3 (66.0)	50.4 (56.4)	17.6 (43.0)
19.6	31.8 (43.7)	28.2 (32.4)	17.6 (25.3)
117.6	25.9 (31.9)	18.0 (22.0)	11.6 (14.1)
	NORMAL FORCE[3,4]		
0.015 inch			
10.7	4.2 (2.7 to 5.6)	1.7 (1.4 to 2.3)	-0.2 (-0.7 to 0.5)
19.6	2.9 (1.7 to 4.1)	1.1 (.7 to 1.6)	.0 (-.4 to .3)
117.6	2.7 (1.9 to 3.6)	1.2 (.6 to 1.8)	.5 (-.1 to 1.2)
0.030 inch			
10.7	8.1 (5.0 to 10.2)	3.4 (2.7 to 4.1)	-.9 (-1.6 to -.1)
19.6	4.9 (2.9 to 6.1)	1.7 (1.2 to 2.1)	-.5 (-.8 to .1)
117.6	3.9 (2.5 to 5.0)	1.2 (.7 to 1.8)	-.1 (-.7 to .9)
0.045 inch			
10.7	11.0 (7.2 to 13.9)	4.1 (3.4 to 4.7)	-.8 (-2.6 to .4)
19.6	6.3 (3.2 to 8.3)	2.1 (1.5 to 2.7)	-.8 (-1.3 to .0)
117.6	5.1 (3.4 to 6.4)	1.3 (.6 to 2.1)	-.2 (-.8 to .5)
0.060 inch			
10.7	13.5 (8.7 to 16.9)	5.6 (5.1 to 6.2)	-1.2 (-3.4 to .1)
19.6	7.9 (3.7 to 9.9)	2.6 (1.8 to 3.3)	-1.0 (-2.0 to .2)
117.6	5.6 (3.3 to 7.4)	1.4 (.5 to 2.4)	-.5 (-1.1 to .4)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five)

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five)

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 5C.--TOOL FORCES WHEN ORTHOGONALLY CUTTING HACKBERRY ACROSS THE GRAIN IN THE 90-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	20	30	40
	Pounds per 0.1 inch of knife		
	PARALLEL FORCE[2]		
0.015 inch			
10.6	20.2 (25.7)	17.7 (20.9)	15.1 (18.3)
18.9	18.1 (21.8)	13.8 (16.4)	11.1 (13.3)
111.7	10.9 (12.3)	9.2 (10.5)	7.7 (8.8)
0.030 inch			
10.6	36.6 (43.7)	32.3 (37.7)	25.6 (29.6)
18.9	29.7 (35.9)	20.5 (24.4)	17.1 (20.0)
111.7	21.0 (22.6)	15.1 (17.2)	12.1 (14.9)
0.045 inch			
10.6	43.7 (53.1)	38.1 (45.1)	31.9 (38.3)
18.9	37.5 (42.9)	27.6 (32.4)	22.0 (26.4)
111.7	26.6 (29.7)	19.9 (22.3)	15.6 (18.4)
0.060 inch			
10.6	53.1 (67.0)	46.4 (55.0)	39.1 (48.6)
18.9	45.0 (51.1)	33.8 (38.5)	26.6 (32.2)
111.7	33.0 (37.2)	23.6 (27.6)	19.2 (22.0)
	NORMAL FORCE[3,4]		
0.015 inch			
10.6	2.3 (0.9 to 3.8)	0.0 (-1.0 to 1.3)	-2.5 (-3.5 to -1.3)
18.9	1.4 (.8 to 2.0)	-.7 (-1.4 to .2)	-1.8 (-2.4 to -1.2)
111.7	.9 (.5 to 1.1)	-.1 (-.8 to .4)	-1.4 (-2.1 to -.9)
0.030 inch			
10.6	3.4 (.8 to 6.5)	-1.8 (-3.9 to .2)	-5.1 (-6.7 to -3.1)
18.9	1.4 (.5 to 2.8)	-1.9 (-3.2 to -.9)	-4.1 (-5.2 to -3.1)
111.7	.5 (-.1 to 1.2)	-1.3 (-2.3 to -.6)	-3.3 (-4.1 to -2.5)
0.045 inch			
10.6	4.1 (1.4 to 8.4)	-2.1 (-4.9 to 2.2)	-7.0 (-9.3 to -3.2)
18.9	1.5 (.3 to 3.2)	-3.1 (-4.7 to -1.7)	-6.0 (-7.8 to -4.1)
111.7	.6 (-.2 to 1.5)	-2.3 (-3.2 to -1.3)	-4.6 (-6.0 to -3.4)
0.060 inch			
10.6	5.1 (1.7 to 10.0)	-2.8 (-6.2 to 2.2)	-8.8 (-12.2 to -2.7)
18.9	2.1 (.1 to 3.8)	-4.1 (-6.1 to -2.3)	-7.6 (-9.9 to -4.6)
111.7	.5 (-.6 to 1.7)	-3.3 (-5.2 to -1.8)	-6.2 (-7.6 to -4.7)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five)

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece

TABLE 6A.--TOOL FORCES WHEN ORTHOGONALLY CUTTING HICKORY VENEER IN THE 0-90 DIRECTION[1]

Depth of cut and moisutre content (percent)	Rake angle, degrees		
	50	60	70
	Pounds per 0.1 inch of knife		
	PARALLEL FORCE[2]		
0.015 inch			
12.1	3.6 (8.1)	4.1 (7.6)	3.5 (5.4)
20.5	2.9 (5.6)	2.6 (4.5)	6.1 (11.3)
98.2	1.9 (3.4)	1.7 (3.0)	4.3 (7.7)
0.030 inch			
12.1	5.9 (14.6)	5.9 (12.4)	4.4 (8.5)
20.5	4.5 (9.0)	4.1 (7.6)	3.9 (5.6)
98.2	3.2 (6.2)	2.7 (4.7)	2.7 (3.7)
0.045 inch			
12.1	7.3 (18.3)	6.6 (15.0)	5.9 (11.5)
20.5	5.6 (11.1)	5.0 (10.2)	4.7 (7.6)
98.2	3.9 (7.9)	3.3 (6.0)	3.2 (4.6)
0.060 inch			
12.1	8.5 (22.2)	7.5 (18.1)	7.2 (14.2)
20.5	6.3 (13.9)	5.6 (11.5)	5.5 (9.5)
98.2	4.6 (10.1)	3.9 (7.3)	3.9 (5.9)
	NORMAL FORCE[3,4]		
0.015 inch			
12.1	-0.3 (-1.4 to 0.8)	0.8 (-0.3 to 2.0)	0.1 (-0.7 to 1.1)
20.5	-.2 (-1.0 to 1.3)	-.3 (-1.0 to .4)	.3 (-1.8 to 2.2)
98.2	-.1 (-.6 to .6)	-.1 (-.7 to .4)	-.5 (-2.0 to 1.2)
0.030 inch			
12.1	-.4 (-2.4 to 1.7)	.5 (-1.6 to 2.4)	.6 (-.8 to 1.8)
20.5	-.4 (-1.8 to 1.1)	-1.1 (-2.5 to .3)	-.4 (-1.4 to .7)
98.2	-.4 (-1.3 to .5)	-.7 (-1.5 to .4)	-.1 (-.6 to .6)
0.045 inch			
12.1	-.3 (-3.3 to 2.2)	-.1 (-2.6 to 2.1)	.2 (-2.2 to 1.6)
20.5	-.8 (-2.6 to 1.3)	-1.4 (-3.4 to .5)	-.8 (-2.5 to .8)
98.2	-.5 (-1.6 to .5)	-.8 (-1.9 to .2)	-.6 (-1.2 to .2)
0.060 inch			
12.1	-.5 (-2.8 to 1.8)	-.4 (-2.7 to 2.5)	-.3 (-2.6 to 1.4)
20.5	-.6 (-3.0 to 2.0)	-1.8 (-4.1 to .4)	-1.6 (-3.5 to .6)
98.2	-.6 (-1.8 to .7)	-1.0 (-1.8 to .7)	-.8 (-1.8 to .3)

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[1] Clearance angle 0°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five)

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 6B.--TOOL FORCES WHEN ORTHOGONALLY CUTTING HICKORY PARALLEL TO THE GRAIN IN THE 90-0 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	10	20	30
	Pounds per 0.1 inch of knife		
	PARALLEL FORCE[2]		
0.015 inch			
11.0	18.2 (21.9)	17.8 (19.7)	9.5 (14.5)
19.6	10.7 (12.4)	8.3 (10.0)	6.3 (7.7)
91.2	7.2 (9.1)	6.0 (7.5)	3.9 (4.7)
0.030 inch			
11.0	37.2 (45.2)	40.9 (45.2)	16.7 (26.7)
19.6	21.4 (24.5)	16.0 (18.3)	13.1 (15.9)
91.2	14.4 (18.0)	10.9 (12.9)	6.9 (8.4)
0.045 inch			
11.0	47.6 (62.2)	47.5 (52.7)	14.7 (35.1)
19.6	29.1 (33.0)	21.9 (26.5)	17.4 (19.8)
91.2	20.1 (24.0)	14.6 (17.1)	8.4 (11.9)
0.060 inch			
11.0	59.5 (78.0)	58.5 (71.7)	19.8 (49.5)
19.6	36.1 (42.9)	28.5 (34.3)	19.1 (25.5)
91.2	26.9 (31.7)	18.6 (22.5)	10.0 (14.4)
	NORMAL FORCE[3,4]		
0.015 inch			
11.0	5.2 (4.4 to 6.3)	2.0 (1.5 to 2.5)	-0.3 (-0.9 to 0.3)
19.6	3.0 (2.3 to 3.4)	1.1 (.8 to 1.4)	-.2 (-.4 to .2)
91.2	2.3 (1.7 to 2.9)	.9 (.5 to 1.4)	.3 (.0 to .6)
0.030 inch			
11.0	9.7 (7.2 to 11.5)	3.7 (2.9 to 4.5)	-.9 (-2.2 to .1)
19.6	5.5 (4.3 to 6.3)	1.8 (1.4 to 2.1)	-.8 (-1.2 to -.4)
91.2	3.6 (2.6 to 4.5)	1.2 (.9 to 1.9)	-.1 (-.4 to .3)
0.045 inch			
11.0	12.2 (7.2 to 16.5)	4.3 (2.9 to 5.5)	-1.1 (-3.1 to .5)
19.6	6.9 (5.1 to 7.9)	2.5 (2.0 to 3.0)	-1.1 (-1.6 to -.5)
91.2	4.7 (3.0 to 6.0)	1.3 (1.0 to 1.7)	-.2 (-.6 to .3)
0.060 inch			
11.0	14.4 (8.4 to 20.0)	5.8 (3.0 to 7.3)	-1.4 (-4.0 to .0)
19.6	8.5 (6.9 to 9.9)	2.9 (1.9 to 3.7)	-1.2 (-2.2 to -.5)
91.2	5.8 (4.1 to 7.2)	1.5 (1.0 to 2.0)	-.6 (-1.2 to -.1)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 6C.--TOOL FORCES WHEN ORTHOGONALLY CUTTING HICKORY ACROSS THE GRAIN IN THE 90-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	20	30	40
	Pounds per 0.1 inch of knife		
	PARALLEL FORCE[2]		
0.015 inch			
10.7	25.8 (32.2)	21.8 (28.6)	16.3 (20.2)
20.0	19.7 (22.6)	15.1 (17.8)	14.8 (17.9)
85.9	12.8 (15.1)	13.0 (14.5)	9.0 (10.6)
0.030 inch			
10.7	42.6 (52.4)	36.8 (45.2)	29.0 (35.3)
20.0	34.1 (39.8)	25.9 (30.3)	22.4 (27.1)
85.9	23.9 (26.3)	19.3 (22.2)	14.7 (16.5)
0.045 inch			
10.7	49.1 (61.2)	49.2 (61.9)	35.3 (44.2)
20.0	43.2 (48.2)	33.6 (39.5)	29.1 (35.4)
85.9	31.9 (36.6)	23.5 (27.2)	18.6 (21.0)
0.060 inch			
10.7	56.0 (71.1)	52.1 (68.8)	46.1 (55.1)
20.0	52.6 (59.8)	40.5 (49.1)	34.6 (41.7)
85.9	38.8 (43.5)	29.3 (35.5)	22.0 (25.3)
	NORMAL FORCE[3,4]		
0.015 inch			
10.7	0.9 (-0.4 to 2.4)	-1.8 (-3.5 to -0.8)	-4.3 (-5.7 to -2.6)
20.0	1.2 (.6 to 1.8)	-1.4 (-2.1 to -.5)	-2.9 (-4.0 to -1.9)
85.9	.5 (.0 to 1.1)	-1.1 (-1.9 to -.3)	-2.2 (-2.8 to -1.4)
0.030 inch			
10.7	.2 (-2.1 to 2.4)	-4.8 (-7.1 to -2.9)	-8.7 (-11.4 to -5.4)
20.0	.8 (-.1 to 2.0)	-3.5 (-4.8 to -2.0)	-6.0 (-8.1 to -4.1)
85.9	.0 (-1.0 to .8)	-2.6 (-3.8 to -1.3)	-4.3 (-5.4 to -3.1)
0.045 inch			
10.7	.2 (-3.3 to 3.4)	-7.0 (-10.2 to -3.7)	-11.6 (-14.8 to -6.7)
20.0	1.0 (-.7 to 2.6)	-4.8 (-7.1 to -2.8)	-8.4 (-10.7 to -5.1)
85.9	-.3 (-1.5 to 1.2)	-3.7 (-5.5 to -2.0)	-6.0 (-7.7 to -3.7)
0.060 inch			
10.7	.2 (-4.0 to 5.6)	-8.3 (-11.9 to -3.2)	-15.1 (-19.1 to -9.7)
20.0	1.3 (-.3 to 2.9)	-6.4 (-9.2 to -3.5)	-10.9 (-14.5 to -6.1)
85.9	.1 (-1.3 to 1.8)	-4.8 (-7.5 to -2.7)	-7.8 (-10.0 to -4.8)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five)

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece

TABLE 7A.--TOOL FORCES WHEN ORTHOGONALLY CUTTING RED MAPLE VENEER IN THE 0-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	50	60	70
	-------------*Pounds per 0.1 inch of knife*	-------------	-------------
		PARALLEL FORCE[2]	
0.015 inch			
11.7	2.6 (4.4)	2.6 (4.1)	3.2 (5.2)
18.8	2.3 (3.5)	1.8 (2.7)	3.4 (7.3)
136.2	1.9 (2.8)	1.6 (2.1)	2.9 (5.2)
0.030 inch			
11.7	3.4 (7.4)	3.5 (6.2)	3.0 (4.7)
18.8	3.2 (5.0)	2.8 (4.2)	2.4 (3.7)
136.2	2.6 (4.0)	2.3 (3.2)	1.9 (2.5)
0.045 inch			
11.7	4.2 (10.0)	3.8 (7.8)	3.6 (6.3)
18.8	3.8 (7.2)	3.4 (5.5)	3.0 (4.5)
136.2	2.8 (5.1)	2.7 (4.1)	2.3 (3.4)
0.060 inch			
11.7	4.5 (11.4)	4.1 (9.4)	4.1 (7.7)
18.8	4.1 (7.7)	3.7 (7.0)	3.4 (5.3)
136.2	3.5 (6.2)	2.9 (4.6)	2.7 (4.1)
		NORMAL FORCE[3,4]	
0.015 inch			
11.7	0.1 (-0.3 to 1.0)	0.0 (-0.4 to 0.5)	-0.5 (-1.4 to 0.3)
18.8	.0 (-.5 to .7)	-.3 (-.7 to .0)	-.4 (-1.4 to 1.0)
136.2	.1 (-.3 to .5)	-.1 (-.4 to .3)	-.5 (-1.4 to 1.0)
0.030 inch			
11.7	-.3 (-1.2 to .6)	-.4 (-1.3 to .4)	-.2 (-.8 to .4)
18.8	-.7 (-1.2 to .0)	-.9 (-1.5 to -.1)	-.5 (-.9 to -.1)
136.2	-.3 (-.8 to .3)	-.5 (-1.0 to .0)	.0 (-.3 to .5)
0.045 inch			
11.7	-.5 (-1.7 to .7)	-.6 (-1.9 to .7)	-.6 (-1.4 to .2)
18.8	-.7 (-1.7 to .1)	-1.0 (-2.1 to -.2)	-1.1 (-1.7 to -.2)
136.2	-.4 (-1.1 to .4)	-.7 (-1.5 to -.1)	-.5 (-.9 to .2)
0.060 inch			
11.7	-.6 (-2.1 to .7)	-.7 (-2.2 to .7)	-.6 (-1.9 to .5)
18.8	-1.0 (-2.2 to .1)	-1.4 (-2.6 to .0)	-1.3 (-2.4 to .1)
136.2	-.6 (-1.5 to .3)	-.8 (-1.9 to .0)	-.8 (-1.4 to .0)

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[1] Clearance angle 0°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 7B.--TOOL FORCES WHEN ORTHOGONALLY CUTTING RED MAPLE PARALLEL TO THE GRAIN IN THE 90-0 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	10	20	30
	Pounds per 0.1 inch of knife		
		PARALLEL FORCE[2]	
0.015 inch			
10.8	13.6 (19.1)	13.2 (14.4)	10.5 (13.2)
18.7	10.2 (13.2)	7.5 (8.7)	7.4 (8.4)
124.8	7.7 (10.0)	5.4 (7.2)	4.7 (5.7)
0.030 inch			
10.8	25.2 (36.1)	27.1 (29.2)	13.5 (25.4)
18.7	17.3 (23.8)	16.9 (18.7)	14.2 (17.0)
124.8	14.8 (17.8)	11.2 (13.4)	8.5 (10.2)
0.045 inch			
10.8	34.3 (48.5)	37.4 (40.8)	11.6 (35.6)
18.7	24.3 (33.6)	25.5 (28.0)	16.7 (22.7)
124.8	21.2 (25.1)	16.7 (18.9)	10.6 (13.1)
0.060 inch			
10.8	43.7 (62.4)	47.3 (51.6)	12.8 (45.0)
18.7	31.5 (44.3)	31.9 (34.4)	18.3 (29.6)
124.8	27.0 (32.3)	22.0 (25.0)	13.2 (18.7)
		NORMAL FORCE[3,4]	
0.015 inch			
10.8	4.1 (2.5 to 6.0)	2.0 (1.6 to 2.5)	-0.1 (-0.5 to 0.5)
18.7	3.3 (2.1 to 4.8)	1.4 (1.0 to 1.7)	.2 (-.2 to .6)
124.8	2.8 (1.6 to 4.2)	.9 (.4 to 2.1)	.6 (.0 to 1.1)
0.030 inch			
10.8	7.0 (4.2 to 9.3)	3.6 (3.3 to 4.1)	-.6 (-1.5 to .5)
18.7	4.7 (2.9 to 6.4)	2.1 (1.7 to 2.5)	-.4 (-1.0 to .2)
124.8	3.5 (2.7 to 4.7)	.9 (.5 to 1.4)	.0 (-.6 to .4)
0.045 inch			
10.8	8.8 (4.9 to 11.8)	4.8 (4.2 to 5.2)	-.6 (-2.2 to .4)
18.7	6.4 (3.4 to 8.4)	2.9 (2.3 to 3.3)	-.7 (-1.5 to .2)
124.8	4.8 (3.4 to 6.1)	1.1 (.5 to 1.9)	-.3 (-1.1 to .5)
0.060 inch			
10.8	11.3 (6.4 to 15.4)	5.7 (4.6 to 6.5)	-.6 (-2.8 to .3)
18.7	7.6 (4.5 to 12.3)	3.1 (2.8 to 3.5)	-.8 (-2.0 to .4)
124.8	5.1 (3.1 to 6.6)	1.2 (.5 to 2.1)	-.9 (-2.1 to .3)

[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 7C.--TOOL FORCES WHEN ORTHOGONALLY CUTTING RED MAPLE ACROSS THE GRAIN IN THE 90-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	20	30	40
	Pounds per 0.1 inch of knife		
		PARALLEL FORCE[2]	
0.015 inch			
11.3	18.3 (22.7)	16.1 (20.6)	12.6 (14.4)
18.3	14.9 (18.1)	12.6 (14.5)	9.5 (11.4)
135.1	12.0 (13.7)	9.5 (10.5)	8.1 (9.0)
0.030 inch			
11.3	29.1 (36.3)	25.6 (30.9)	19.1 (22.7)
18.3	26.1 (30.9)	20.1 (23.2)	15.1 (17.9)
135.1	19.3 (21.5)	15.1 (17.2)	11.2 (13.3)
0.045 inch			
11.3	34.6 (46.9)	36.5 (43.5)	26.7 (32.4)
18.3	33.1 (38.1)	26.7 (30.2)	19.6 (24.1)
135.1	26.3 (30.5)	19.4 (22.7)	14.1 (17.1)
0.060 inch			
11.3	32.0 (48.1)	40.4 (53.1)	28.3 (36.2)
18.3	41.3 (46.1)	32.1 (35.9)	24.1 (29.6)
135.1	31.9 (36.9)	24.5 (27.6)	17.5 (20.7)
		NORMAL FORCE[3,4]	
0.015 inch			
11.3	2.8 (1.7 to 4.8)	1.1 (-0.7 to 2.7)	-0.9 (-2.0 to 0.4)
18.3	1.7 (1.1 to 2.6)	.3 (-.4 to 1.1)	-1.1 (-1.7 to -.5)
135.1	.8 (.5 to 1.3)	.0 (-.3 to .5)	-1.2 (-1.6 to -.9)
0.030 inch			
11.3	4.6 (2.5 to 7.8)	1.0 (-1.4 to 4.5)	-2.8 (-4.5 to -.6)
18.3	2.2 (1.2 to 3.4)	-.7 (-2.0 to .4)	-2.9 (-3.7 to -1.8)
135.1	1.0 (.4 to 1.4)	-.9 (-1.6 to .0)	-2.4 (-3.3 to -1.7)
0.045 inch			
11.3	6.7 (2.3 to 12.6)	1.8 (-1.9 to 6.8)	-4.2 (-6.3 to .0)
18.3	2.4 (1.3 to 4.2)	-1.7 (-3.0 to .1)	-4.4 (-6.4 to -2.9)
135.1	.3 (.1 to 1.9)	-1.6 (-2.6 to -.5)	-3.5 (-5.1 to -2.6)
0.060 inch			
11.3	8.4 (1.1 to 16.5)	1.5 (-3.6 to 7.6)	-4.1 (-7.9 to 1.4)
18.3	2.4 (.9 to 4.9)	-2.4 (-4.2 to -.1)	-6.2 (-8.6 to -3.4)
135.1	1.0 (-.3 to 2.2)	-2.5 (-3.8 to -1.1)	-4.7 (-6.4 to -3.1)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 8A.--TOOL FORCES WHEN ORTHOGONALLY CUTTING BLACK OAK VENEER IN THE 0-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	50	60	70
	Pounds per 0.1 inch of knife		
	PARALLEL FORCE[2]		
0.015 inch			
10.6	3.5 (9.3)	3.3 (8.0)	3.4 (6.3)
18.5	2.8 (6.8)	2.5 (5.6)	5.5 (12.0)
92.3	2.0 (5.1)	1.9 (4.8)	4.3 (8.5)
0.030 inch			
10.6	4.9 (13.4)	4.7 (11.3)	5.0 (10.4)
18.5	3.8 (10.6)	4.4 (8.8)	3.6 (6.8)
92.3	3.4 (7.7)	2.9 (6.1)	2.6 (5.7)
0.045 inch			
10.6	5.6 (17.7)	5.5 (14.6)	5.3 (12.1)
18.5	4.5 (10.8)	5.2 (11.6)	4.4 (8.3)
92.3	3.9 (9.0)	3.6 (7.8)	3.5 (6.9)
0.060 inch			
10.6	6.6 (19.4)	5.9 (16.0)	6.6 (14.2)
18.5	5.8 (14.4)	5.5 (12.2)	5.2 (11.0)
92.3	4.5 (10.4)	4.0 (8.6)	3.8 (8.0)
	NORMAL FORCE[3,4]		
0.015 inch			
10.6	0.6 (-0.8 to 3.8)	0.9 (-0.2 to 3.1)	0.3 (-0.7 to 2.0)
18.5	.7 (-.8 to 2.7)	.3 (-.9 to 2.0)	.5 (-1.9 to 2.7)
92.3	.4 (-.5 to 1.6)	.2 (-.7 to 1.3)	.2 (-1.4 to 1.9)
0.030 inch			
10.6	.4 (-1.7 to 3.9)	.6 (-1.4 to 3.1)	1.5 (-.4 to 3.5)
18.5	.0 (-1.5 to 2.1)	.0 (-1.7 to 1.7)	.3 (-.7 to 1.8)
92.3	.0 (-1.0 to 1.4)	-.3 (-1.6 to .9)	.4 (-.7 to 1.5)
0.045 inch			
10.6	.8 (-1.6 to 6.3)	.6 (-1.5 to 3.7)	.8 (-1.8 to 3.8)
18.5	.0 (-1.7 to 1.7)	-.1 (-1.9 to 1.9)	-.3 (-1.6 to 1.8)
92.3	-.1 (-1.2 to 1.3)	-.4 (-2.4 to 1.3)	.0 (-1.0 to 1.2)
0.060 inch			
10.6	.3 (-2.1 to 4.8)	.3 (-2.1 to 3.9)	.8 (-2.2 to 4.1)
18.5	-.4 (-2.1 to 2.1)	-.1 (-2.4 to 2.6)	-.6 (-2.3 to 1.6)
92.3	-.3 (-1.8 to 1.1)	-.7 (-2.5 to 1.3)	-.2 (-1.5 to 1.1)

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[1] Clearance angle 0°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 8B.--TOOL FORCES WHEN ORTHOGONALLY CUTTING BLACK OAK PARALLEL TO THE GRAIN IN THE 90-0 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	10	20	30
	Pounds per 0.1 inch of knife		
		PARALLEL FORCE[2]	
0.015 inch			
10.6	19.2 (23.4)	15.2 (18.3)	9.8 (14.7)
18.3	13.2 (15.3)	10.5 (12.3)	8.3 (9.7)
90.5	8.4 (10.1)	7.2 (8.8)	4.9 (6.2)
0.030 inch			
10.6	36.3 (42.0)	32.8 (39.0)	13.4 (26.1)
18.3	27.1 (31.9)	23.7 (26.6)	15.0 (18.8)
90.5	17.7 (20.7)	12.6 (15.8)	9.0 (12.3)
0.045 inch			
10.6	47.9 (58.0)	41.7 (52.7)	16.8 (40.2)
18.3	36.9 (43.4)	31.7 (35.0)	19.4 (25.5)
90.5	25.6 (31.3)	20.0 (23.4)	9.3 (15.2)
0.060 inch			
10.6	57.6 (73.2)	52.0 (63.8)	17.7 (44.3)
18.3	45.1 (54.6)	39.3 (44.8)	21.7 (33.6)
90.5	33.1 (41.3)	23.6 (30.4)	10.9 (18.2)
		NORMAL FORCE[3,4]	
0.015 inch			
10.6	5.2 (3.7 to 6.2)	1.8 (1.3 to 2.3)	-0.5 (-1.0 to 0.1)
18.3	3.4 (2.6 to 4.2)	1.5 (1.1 to 1.9)	-.2 (-.7 to .3)
90.5	2.4 (1.8 to 2.9)	.9 (.5 to 1.2)	.2 (-.4 to .9)
0.030 inch			
10.6	8.6 (5.8 to 10.6)	3.3 (2.1 to 4.5)	-1.0 (-2.1 to .1)
18.3	6.6 (5.3 to 7.7)	2.1 (1.5 to 2.5)	-1.0 (-1.7 to -.2)
90.5	4.2 (3.6 to 5.1)	1.0 (.6 to 1.4)	-.6 (-1.2 to .0)
0.045 inch			
10.6	11.6 (8.4 to 14.7)	4.0 (2.3 to 5.2)	-1.1 (-2.9 to .4)
18.3	9.1 (7.2 to 10.5)	2.6 (1.8 to 3.1)	-1.0 (-2.0 to -.1)
90.5	5.8 (3.7 to 6.7)	1.2 (.7 to 1.8)	-.5 (-1.5 to .2)
0.060 inch			
10.6	12.8 (7.1 to 17.6)	5.1 (3.3 to 6.9)	-1.3 (-3.4 to .0)
18.3	10.5 (8.2 to 12.8)	2.9 (2.1 to 3.8)	-2.0 (-3.3 to -.9)
90.5	7.7 (5.4 to 9.2)	1.3 (.7 to 2.2)	-.8 (-1.7 to -.1)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 8C.--TOOL FORCES WHEN ORTHOGONALLY CUTTING BLACK OAK ACROSS THE GRAIN IN THE 90-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	20	30	40
	Pounds per 0.1 inch of knife		
	PARALLEL FORCE[2]		
0.015 inch			
10.7	21.6 (28.6)	17.7 (24.1)	14.5 (19.3)
18.3	16.4 (20.6)	13.2 (16.9)	11.9 (15.5)
99.4	14.8 (17.9)	11.1 (13.9)	8.9 (11.7)
0.030 inch			
10.7	37.9 (50.2)	32.0 (42.2)	24.2 (31.2)
18.3	30.0 (36.5)	23.6 (28.6)	19.8 (25.1)
99.4	24.1 (28.6)	17.6 (20.9)	14.4 (18.4)
0.045 inch			
10.7	44.1 (55.3)	37.4 (47.5)	30.7 (38.2)
18.3	37.0 (46.5)	31.0 (38.9)	24.4 (31.8)
99.4	32.1 (37.7)	22.2 (26.6)	18.2 (22.9)
0.060 inch			
10.7	49.8 (63.2)	45.9 (60.7)	34.9 (45.5)
18.3	46.6 (58.5)	37.2 (45.1)	29.4 (36.5)
99.4	38.9 (46.8)	27.2 (32.4)	22.6 (28.3)
	NORMAL FORCE[3,4]		
0.015 inch			
10.7	2.0 (0.7 to 3.6)	-0.7 (-2.1 to 1.2)	-2.7 (-4.4 to -1.0)
18.3	1.3 (.5 to 2.1)	-.7 (-1.7 to 1.0)	-2.0 (-3.3 to -.8)
99.4	.8 (.2 to 1.2)	-.7 (-1.5 to .3)	-1.9 (-3.0 to -.8)
0.030 inch			
10.7	2.6 (.4 to 5.4)	-3.0 (-5.6 to .8)	-5.4 (-8.6 to -2.7)
18.3	1.2 (.2 to 3.3)	-2.4 (-4.4 to -.6)	-4.8 (-6.9 to -3.1)
99.4	.7 (-.2 to 1.4)	-1.7 (-2.7 to -.5)	-4.0 (-5.4 to -2.0)
0.045 inch			
10.7	3.5 (.1 to 7.1)	-4.0 (-7.1 to .9)	-7.5 (-11.2 to -3.1)
18.3	1.8 (-.3 to 3.6)	-3.5 (-6.1 to -.4)	-6.8 (-10.0 to -4.0)
99.4	.9 (-.7 to 2.7)	-2.7 (-4.1 to -1.3)	-5.2 (-7.0 to -3.1)
0.060 inch			
10.7	4.6 (.5 to 8.9)	-4.4 (-8.9 to 1.7)	-9.1 (-12.6 to -4.3)
18.3	2.0 (-.4 to 4.9)	-5.3 (-7.7 to -1.2)	-8.7 (-11.6 to -4.2)
99.4	1.0 (-.9 to 2.6)	-3.5 (-5.0 to -1.8)	-6.8 (-10.0 to -3.2)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 9A.--TOOL FORCES WHEN ORTHOGONALLY CUTTING BLACKJACK OAK VENEER IN THE 0-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	50	60	70
	Pounds per 0.1 inch of knife		
	PARALLEL FORCE[2]		
0.015 inch			
11.7	3.9 (8.9)	4.4 (8.9)	3.7 (7.1)
19.2	2.9 (6.2)	5.8 (11.9)	2.9 (5.5)
82.5	2.1 (5.1)	4.2 (8.4)	2.4 (4.6)
0.030 inch			
11.7	5.8 (14.5)	4.6 (9.9)	4.9 (10.6)
19.2	4.4 (9.3)	3.6 (6.9)	3.9 (7.4)
82.5	4.0 (7.4)	2.8 (5.4)	3.2 (5.9)
0.045 inch			
11.7	6.7 (15.9)	5.4 (12.6)	6.0 (14.0)
19.2	5.2 (10.1)	4.3 (8.6)	4.8 (8.3)
82.5	4.6 (9.1)	3.6 (7.6)	3.9 (7.3)
0.060 inch			
11.7	7.9 (19.3)	6.4 (14.3)	7.2 (15.5)
19.2	6.0 (12.0)	5.6 (10.6)	5.8 (10.8)
82.5	5.3 (11.2)	4.6 (8.8)	4.6 (7.6)
	NORMAL FORCE[3,4]		
0.015 inch			
11.7	-0.2 (-1.3 to 1.5)	-0.5 (-2.3 to .9)	0.5 (-0.6 to 1.6)
19.2	.0 (-.9 to 1.7)	-.6 (-2.3 to 1.1)	-.2 (-.8 to .8)
82.5	-.1 (-.8 to .6)	-1.0 (-3.2 to .3)	.1 (-.5 to .8)
0.030 inch			
11.7	-.5 (-2.2 to 1.6)	-.4 (-2.0 to .9)	-.5 (-2.1 to .8)
19.2	-.9 (-2.0 to .3)	-.8 (-1.8 to .5)	-1.2 (-2.4 to .2)
82.5	-.8 (-2.0 to .3)	-.8 (-2.0 to -.1)	-.9 (-1.8 to .1)
0.045 inch			
11.7	-.5 (-2.9 to 2.1)	-.9 (-2.8 to .5)	-.8 (-2.9 to 1.2)
19.2	-1.0 (-2.6 to .4)	-1.3 (-3.0 to .2)	-1.5 (-3.0 to .2)
82.5	-1.1 (-2.6 to .2)	-1.3 (-2.9 to -.3)	-1.4 (-2.6 to .1)
0.060 inch			
11.7	-.9 (-4.2 to 1.4)	-1.0 (-3.0 to .8)	-1.4 (-4.0 to .7)
19.2	-1.5 (-3.2 to .1)	-1.8 (-3.9 to -.1)	-2.3 (-3.8 to .0)
82.5	-1.3 (-2.7 to .0)	-1.7 (-3.7 to .0)	-2.2 (-3.4 to -.4)

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[1] Clearance angle 0°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 9B.--TOOL FORCES WHEN ORTHOGONALLY CUTTING BLACKJACK OAK PARALLEL TO THE GRAIN IN THE 90-0 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	10	20	30
	Pounds per 0.1 inch of knife		
	PARALLEL FORCE[2]		
0.015 inch			
11.6	19.0 (22.7)	15.2 (18.2)	10.1 (14.6)
19.2	12.1 (13.8)	10.6 (12.2)	7.3 (9.0)
80.8	9.2 (10.7)	6.9 (8.4)	4.5 (6.0)
0.030 inch			
11.6	33.2 (41.9)	31.3 (36.0)	17.8 (27.6)
19.2	24.9 (29.1)	20.8 (24.1)	12.2 (16.5)
80.8	17.2 (20.1)	12.3 (15.3)	7.4 (9.8)
0.045 inch			
11.6	48.1 (56.4)	40.0 (46.2)	19.9 (38.2)
19.2	31.7 (39.3)	27.1 (30.1)	15.5 (19.9)
80.8	23.8 (27.6)	17.2 (21.4)	10.1 (13.0)
0.060 inch			
11.6	57.7 (73.4)	53.7 (63.0)	20.4 (50.7)
19.2	42.3 (48.6)	35.7 (40.2)	16.8 (25.5)
80.8	30.6 (36.1)	22.7 (27.7)	11.9 (15.7)
	NORMAL FORCE[3,4]		
0.015 inch			
11.6	5.3 (4.0 to 6.4)	1.7 (1.1 to 2.3)	-0.3 (-0.8 to 0.2)
19.2	3.4 (2.5 to 4.1)	1.3 (.8 to 1.5)	-.3 (-.6 to .1)
80.8	2.5 (1.8 to 3.2)	.8 (.5 to 1.1)	-.2 (-.5 to .4)
0.030 inch			
11.6	9.0 (6.6 to 10.7)	2.9 (2.2 to 3.7)	-1.1 (-2.6 to .8)
19.2	5.9 (4.3 to 7.1)	1.7 (1.1 to 2.3)	-.9 (-1.4 to -.3)
80.8	4.0 (3.0 to 4.8)	1.0 (.5 to 1.4)	-.6 (-1.0 to -.2)
0.045 inch			
11.6	11.5 (8.4 to 14.1)	3.3 (2.0 to 4.6)	-1.4 (-3.8 to .9)
19.2	7.5 (5.7 to 9.2)	2.1 (1.4 to 2.7)	-1.2 (-1.8 to -.6)
80.8	5.3 (4.0 to 6.2)	1.1 (.6 to 1.7)	-1.0 (-1.5 to -.5)
0.060 inch			
11.6	13.7 (10.2 to 17.1)	4.2 (2.4 to 5.8)	-1.4 (-5.1 to 1.2)
19.2	9.5 (7.1 to 11.0)	2.6 (1.9 to 3.1)	-1.5 (-2.8 to -.3)
80.8	6.3 (4.7 to 7.6)	1.2 (.5 to 1.8)	-1.2 (-1.9 to -.6)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 9C.--TOOL FORCES WHEN ORTHOGONALLY CUTTING BLACKJACK OAK ACROSS THE GRAIN IN THE 90-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	20	30	40
	Pounds per 0.1 inch of knife		
		PARALLEL FORCE[2]	
0.015 inch			
10.9	17.3 (25.6)	15.4 (21.8)	12.2 (17.1)
17.7	16.5 (21.5)	12.9 (16.9)	11.7 (15.0)
89.2	11.9 (15.4)	10.1 (12.4)	8.4 (11.1)
0.030 inch			
10.9	31.5 (41.9)	27.7 (35.4)	20.6 (28.2)
17.7	31.7 (38.5)	22.2 (26.9)	17.7 (21.9)
89.2	21.3 (25.4)	16.4 (19.3)	14.3 (18.2)
0.045 inch			
10.9	33.8 (49.2)	33.3 (46.6)	25.5 (35.7)
17.7	36.7 (43.9)	29.9 (36.3)	23.8 (30.0)
89.2	28.0 (34.9)	21.1 (25.9)	18.3 (25.2)
0.060 inch			
10.9	40.5 (55.4)	40.9 (51.7)	34.1 (45.4)
17.7	43.1 (52.9)	35.4 (43.3)	28.2 (36.1)
89.2	33.7 (42.2)	26.9 (32.8)	22.3 (28.6)
		NORMAL FORCE[3,4]	
0.015 inch			
10.9	1.4 (-0.2 to 4.1)	-0.4 (-2.0 to 1.8)	-2.4 (-4.3 to -0.1)
17.7	1.3 (.3 to 2.8)	-.9 (-2.0 to .1)	-2.5 (-3.8 to -1.1)
89.2	.5 (-.1 to 1.3)	-.9 (-1.8 to .0)	-1.7 (-2.6 to -.7)
0.030 inch			
10.9	2.1 (-1.5 to 7.9)	-1.7 (-4.8 to 3.7)	-5.2 (-8.5 to -1.3)
17.7	1.0 (-.7 to 4.8)	-2.4 (-4.0 to -.6)	-4.7 (-6.4 to -2.6)
89.2	.3 (-.7 to 1.8)	-1.9 (-3.1 to -.3)	-3.9 (-5.7 to -1.7)
0.045 inch			
10.9	2.0 (-2.2 to 8.9)	-2.8 (-7.2 to 3.7)	-7.2 (-11.3 to -3.2)
17.7	1.2 (-.8 to 4.4)	-4.2 (-6.7 to -1.8)	-6.8 (-9.2 to -4.1)
89.2	.6 (-.9 to 3.3)	-2.8 (-4.4 to -.6)	-5.2 (-7.7 to -3.3)
0.060 inch			
10.9	2.6 (-2.6 to 11.6)	-3.7 (-8.1 to 4.2)	-9.1 (-14.0 to -2.7)
17.7	1.2 (-2.1 to 5.0)	-5.2 (-9.0 to -2.4)	-8.6 (-12.1 to -4.2)
89.2	.7 (-1.5 to 4.2)	-3.8 (-5.9 to -.8)	-6.7 (-9.2 to -3.7)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 10A.--TOOL FORCES WHEN ORTHOGONALLY CUTTING CHERRYBARK OAK VENEER IN THE 0-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	50	60	70
	Pounds per 0.1 inch of knife		
		PARALLEL FORCE[2]	
0.015 inch			
11.4	3.8 (9.3)	4.6 (11.6)	3.5 (7.8)
18.8	3.3 (8.1)	2.9 (5.9)	6.5 (14.0)
93.4	2.1 (5.0)	2.4 (4.5)	4.7 (9.6)
0.030 inch			
11.4	5.5 (15.3)	5.5 (14.3)	4.5 (10.6)
18.8	4.4 (9.9)	4.1 (8.0)	3.5 (6.8)
93.4	3.0 (7.3)	3.0 (6.6)	2.5 (5.4)
0.045 inch			
11.4	6.1 (17.8)	6.7 (18.3)	6.2 (14.7)
18.8	5.2 (12.6)	4.7 (9.9)	4.7 (8.7)
93.4	3.8 (8.8)	3.8 (8.8)	3.2 (7.0)
0.060 inch			
11.4	7.9 (21.7)	7.9 (20.4)	6.8 (15.9)
18.8	6.7 (15.0)	5.1 (12.0)	5.0 (9.5)
93.4	4.6 (11.1)	4.3 (9.5)	3.8 (7.9)
		NORMAL FORCE[3,4]	
0.015 inch			
11.4	0.5 (-0.9 to 3.1)	1.2 (-0.4 to 3.2)	-0.1 (-1.6 to 1.6)
18.8	.5 (-1.0 to 2.9)	-.1 (-.9 to 1.6)	.0 (-2.5 to 2.4)
93.4	.3 (-.4 to 1.5)	.0 (-.8 to .9)	-1.0 (-2.4 to 1.3)
0.030 inch			
11.4	.6 (-1.9 to 5.2)	.8 (-1.1 to 3.6)	1.4 (-.3 to 3.6)
18.8	.3 (-1.6 to 3.1)	-.9 (-2.5 to .9)	-.1 (-1.5 to 2.0)
93.4	-.1 (-1.1 to 1.3)	-.5 (-1.6 to .6)	.4 (-.6 to 1.8)
0.045 inch			
11.4	.7 (-1.9 to 5.1)	.7 (-1.5 to 3.9)	.2 (-2.0 to 3.0)
18.8	-.1 (-1.9 to 2.4)	-1.1 (-2.8 to .7)	-.7 (-2.7 to 1.8)
93.4	-.2 (-1.3 to 1.3)	-.7 (-2.2 to 1.3)	-.3 (-1.5 to 1.3)
0.060 inch			
11.4	.8 (-1.9 to 5.9)	.9 (-2.3 to 4.9)	.2 (-2.5 to 3.3)
18.8	-.2 (-2.2 to 2.7)	-1.3 (-3.8 to .8)	-1.3 (-3.6 to 1.1)
93.4	-.5 (-2.1 to 1.6)	-.9 (-2.8 to .7)	-.5 (-1.9 to 1.2)

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[1] Clearance angle 0°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 10B.--TOOL FORCES WHEN ORTHOGONALLY CUTTING CHERRYBARK OAK PARALLEL TO THE GRAIN IN THE 90-0 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	10	20	30
	Pounds per 0.1 inch of knife		
	PARALLEL FORCE[2]		
0.015 inch			
10.4	17.8 (21.5)	16.7 (19.3)	12.9 (16.6)
18.7	11.7 (13.7)	10.1 (12.0)	7.4 (8.4)
87.9	8.5 (10.4)	6.0 (7.3)	4.7 (6.0)
0.030 inch			
10.4	37.0 (45.0)	37.6 (41.8)	21.9 (29.7)
18.7	23.6 (27.0)	19.8 (22.9)	14.6 (17.8)
87.9	16.9 (20.1)	11.9 (13.5)	7.2 (9.1)
0.045 inch			
10.4	47.9 (59.0)	45.8 (52.3)	19.5 (42.6)
18.7	30.0 (38.1)	27.4 (30.5)	17.9 (22.1)
87.9	24.3 (30.0)	17.9 (20.2)	9.3 (11.6)
0.060 inch			
10.4	58.0 (72.9)	55.3 (66.8)	23.9 (49.9)
18.7	38.1 (47.5)	34.3 (36.8)	23.0 (29.5)
87.9	30.0 (34.6)	22.4 (25.7)	13.3 (16.7)
	NORMAL FORCE[3,4]		
0.015 inch			
10.4	5.1 (4.1 to 6.2)	2.0 (1.4 to 2.6)	-0.7 (-1.1 to -0.1)
18.7	3.2 (2.6 to 3.8)	1.2 (.9 to 1.6)	-.1 (-.5 to .3)
87.9	2.4 (2.0 to 3.3)	.8 (.4 to 1.4)	.0 (-.4 to .5)
0.030 inch			
10.4	8.9 (6.1 to 11.3)	3.6 (2.6 to 4.5)	-1.7 (-2.5 to -.7)
18.7	6.0 (4.4 to 7.0)	1.9 (1.5 to 2.3)	-.9 (-1.4 to -.4)
87.9	4.0 (3.2 to 5.0)	1.0 (.6 to 1.6)	-.2 (-.8 to .5)
0.045 inch			
10.4	11.3 (8.0 to 15.2)	4.1 (2.4 to 5.4)	-1.5 (-3.5 to -.1)
18.7	7.4 (5.4 to 8.9)	2.3 (1.8 to 2.9)	-1.3 (-2.1 to -.4)
87.9	5.8 (4.6 to 7.3)	1.1 (.5 to 1.8)	-.5 (-1.2 to .4)
0.060 inch			
10.4	14.7 (10.7 to 18.3)	4.5 (2.5 to 6.3)	-1.6 (-4.2 to .1)
18.7	9.2 (7.0 to 10.9)	3.0 (2.3 to 3.5)	-1.8 (-2.8 to -.7)
87.9	6.7 (5.2 to 8.1)	1.2 (.6 to 1.8)	-1.2 (-2.0 to -.2)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 10C.--TOOL FORCES WHEN ORTHOGONALLY CUTTING CHERRYBARK OAK ACROSS THE GRAIN IN THE 90-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	20	30	40
	Pounds per 0.1 inch of knife		
		PARALLEL FORCE[2]	
0.015 inch			
9.9	25.0 (32.6)	18.1 (24.1)	15.5 (20.7)
18.6	18.0 (22.6)	13.7 (17.3)	11.0 (14.2)
96.0	13.3 (15.6)	10.6 (12.8)	8.7 (11.4)
0.030 inch			
9.9	40.6 (52.3)	35.4 (44.4)	27.3 (34.2)
18.6	30.7 (36.9)	23.4 (28.0)	18.4 (23.3)
96.0	24.7 (28.6)	17.5 (21.9)	14.1 (17.9)
0.045 inch			
9.9	48.5 (61.7)	43.2 (54.2)	32.8 (43.9)
18.6	37.9 (45.1)	29.2 (34.5)	24.2 (29.5)
96.0	32.5 (37.5)	22.5 (27.0)	18.0 (22.1)
0.060 inch			
9.9	63.6 (79.3)	48.2 (63.9)	40.6 (53.5)
18.6	46.2 (54.1)	35.9 (42.9)	28.3 (37.2)
96.0	39.3 (46.2)	27.3 (33.8)	21.2 (27.0)
		NORMAL FORCE[3,4]	
0.015 inch			
9.9	2.3 (1.0 to 3.9)	-0.4 (-1.9 to 1.8)	-2.9 (-5.0 to -1.2)
18.6	1.5 (.6 to 2.6)	-.5 (-1.3 to .5)	-1.9 (-3.0 to -.3)
96.0	.7 (-.1 to 1.6)	-.5 (-1.2 to .0)	-1.9 (-2.7 to -.8)
0.030 inch			
9.9	3.3 (.8 to 7.2)	-2.5 (-5.1 to 1.0)	-6.2 (-8.9 to -2.6)
18.6	1.5 (.0 to 3.6)	-2.2 (-3.7 to -.3)	-4.7 (-6.6 to -2.6)
96.0	.4 (-.7 to 1.7)	-2.2 (-3.4 to -.9)	-3.9 (-5.3 to -2.4)
0.045 inch			
9.9	4.1 (.8 to 7.9)	-3.2 (-6.9 to 2.2)	-8.4 (-12.2 to -3.6)
18.6	1.6 (-.4 to 4.0)	-3.1 (-5.2 to .2)	-6.6 (-8.7 to -3.7)
96.0	.4 (-1.1 to 1.9)	-3.2 (-4.9 to -1.5)	-5.3 (-7.2 to -3.2)
0.060 inch			
9.9	4.9 (.1 to 9.7)	-3.9 (-8.8 to 3.2)	-10.9 (-15.7 to -4.0)
18.6	2.2 (-.5 to 4.8)	-4.5 (-7.3 to -1.6)	-8.7 (-12.1 to -4.2)
96.0	.4 (-1.3 to 2.7)	-4.2 (-6.2 to -1.9)	-6.8 (-9.6 to -3.7)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 11A.--TOOL FORCES WHEN ORTHOGONALLY CUTTING LAUREL OAK VENEER IN THE 0-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	50	60	70
	--------------Pounds per 0.1 inch of knife--------------		
		PARALLEL FORCE[2]	
0.015 inch			
11.1	4.2 (10.0)	4.7 (10.8)	4.1 (8.7)
19.0	2.9 (6.5)	4.9 (12.2)	2.9 (6.3)
91.2	2.5 (5.9)	4.4 (8 9)	2.1 (4.5)
0.030 inch			
11.1	5.0 (13.7)	4.3 (9.2)	5.2 (12.0)
19.0	4.3 (9.3)	3.6 (7.4)	3.8 (8.0)
91.2	3.2 (8.5)	2.8 (5.9)	2.9 (6.1)
0.045 inch			
11.1	5.2 (15.9)	5.2 (13.4)	5.9 (13.6)
19.0	5.0 (10.9)	4.3 (9.3)	4.5 (9.1)
91.2	3.6 (10.1)	3.4 (7.3)	3.5 (6.9)
0.060 inch			
11.1	6.7 (18.5)	6.5 (16.2)	6.8 (15.4)
19.0	6.1 (13.5)	5.8 (11.4)	5.3 (11.5)
91.2	4.1 (10.3)	4.3 (9.4)	4.0 (8.1)
		NORMAL FORCE[3,4]	
0.015 inch			
11.1	0.1 (-1.2 to 2.6)	-0.1 (-1.7 to 2.2)	0.8 (-0.6 to 2.4)
19.0	.2 (-.7 to 2.0)	-.1 (-1.8 to 2.1)	.3 (-.7 to 1.8)
91.2	.2 (-.7 to 1.9)	-.6 (-2.1 to 1.3)	.3 (-.5 to 1.2)
0.030 inch			
11.1	.4 (-1.4 to 3.1)	.7 (-.9 to 2.6)	.3 (-2.1 to 3.6)
19.0	-.4 (-1.9 to 2.0)	-.3 (-1.5 to 1.8)	-.5 (-1.7 to 1.1)
91.2	.2 (-1.2 to 1.8)	-.6 (-1.6 to .5)	-.1 (-1.3 to 1.3)
0.045 inch			
11.1	.1 (-1.8 to 3.0)	.1 (-1.7 to 1.9)	.1 (-2.6 to 3.5)
19.0	-.3 (-2.1 to 1.9)	-.8 (-2.5 to 1.7)	-.8 (-2.4 to 1.2)
91.2	-.1 (-1.8 to 1.9)	-.7 (-2.3 to .6)	-.1 (-1.8 to 2.3)
0.060 inch			
11.1	.1 (-2.0 to 3.3)	.4 (-2.0 to 3.3)	.1 (-2.8 to 3.6)
19.0	-.6 (-2.8 to 1.8)	-1.2 (-3.3 to 1.2)	-1.5 (-3.3 to .3)
91.2	.0 (-1.6 to 2.3)	-1.1 (-3.3 to .9)	-.2 (-1.8 to 1.1)

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[1] Clearance angle 0°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five)

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five)

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece

TABLE 11B.--TOOL FORCES WHEN ORTHOGONALLY CUTTING LAUREL OAK PARALLEL TO THE GRAIN IN THE 90-0 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	10	20	30
	--------------Pounds per 0.1 inch of knife--------------		
	PARALLEL FORCE[2]		
0.015 inch			
10.9	19.0 (22.3)	16.8 (19.3)	11.4 (14.3)
19.0	12.0 (13.5)	10.1 (11.5)	6.6 (8.3)
89.4	8.2 (10.5)	7.0 (8.3)	4.7 (6.1)
0.030 inch			
10.9	36.3 (43.2)	31.6 (35.4)	17.6 (28.9)
19.0	23.7 (29.1)	20.2 (22.2)	12.9 (17.1)
89.4	15.9 (19.7)	12.8 (15.7)	7.8 (10.1)
0.045 inch			
10.9	48.9 (58.0)	44.4 (48.3)	19.3 (40.6)
19.0	30.8 (39.1)	28.3 (32.0)	16.9 (23.2)
89.4	20.5 (27.9)	18.1 (21.8)	10.7 (14.6)
0.060 inch			
10.9	61.3 (77.5)	61.2 (64.1)	18.5 (50.1)
19.0	39.5 (50.7)	35.3 (39.9)	18.7 (31.6)
89.4	27.4 (34.7)	23.4 (28.3)	14.4 (18.0)
	NORMAL FORCE[3,4]		
0.015 inch			
10.9	5.8 (4.9 to 6.8)	2.1 (1.7 to 2.5)	-0.6 (-1.1 to 0.0)
19.0	3.5 (2.8 to 4.1)	1.2 (.9 to 1.6)	-.1 (-.4 to .5)
89.4	2.6 (1.6 to 4.0)	.8 (4 to 1.2)	-.1 (-.5 to .4)
0.030 inch			
10.9	9.7 (7.6 to 11.5)	3.6 (3.1 to 4.2)	-1.3 (-2.4 to -.1)
19.0	6.1 (3.7 to 7.7)	1.9 (1.5 to 2.3)	-.7 (-1.4 to -.1)
89.4	3.7 (2.3 to 4.9)	1.1 (.6 to 1.7)	-.4 (-1.1 to .5)
0.045 inch			
10.9	12.7 (10.5 to 15.2)	4.5 (3.9 to 5.2)	-1.5 (-3.4 to .3)
19.0	7.6 (5.1 to 9.4)	2.4 (1.8 to 2.9)	-1.2 (-2.0 to -.5)
89.4	4.6 (3.0 to 6.3)	1.2 (.7 to 1.8)	-.8 (-1.4 to -.1)
0.060 inch			
10.9	15.4 (11.6 to 18.9)	6.2 (5.4 to 7.0)	-1.5 (-4.4 to .1)
19.0	9.9 (6.8 to 12.4)	2.8 (2.1 to 3.5)	-1.4 (-2.6 to -.7)
89.4	6.0 (4.4 to 7.8)	1.4 (.8 to 2.1)	-1.4 (-2.2 to -.7)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece

TABLE 11C.--TOOL FORCES WHEN ORTHOGONALLY CUTTING LAUREL OAK ACROSS THE GRAIN IN THE 90-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	20	30	40
	Pounds per 0.1 inch of knife		
	PARALLEL FORCE[2]		
0.015 inch			
10.7	23.4 (29.2)	21.2 (27.6)	16.0 (19.3)
18.6	18.3 (21.8)	12.1 (15.6)	10.8 (14.2)
94.4	14.1 (17.6)	12.1 (15.0)	8.3 (11.0)
0.030 inch			
10.7	36.5 (48.6)	33.4 (41.6)	28.1 (35.1)
18.6	33.6 (39.9)	23.9 (29.5)	18.5 (22.2)
94.4	24.8 (30.3)	16.9 (21.1)	13.5 (16.9)
0.045 inch			
10.7	47.9 (59.1)	43.0 (53.7)	34.2 (40.5)
18.6	42.1 (47.7)	30.8 (37.3)	23.5 (29.4)
94.4	32.3 (39.7)	22.9 (29.1)	17.2 (22.7)
0.060 inch			
10.7	49.5 (70.5)	48.1 (63.0)	43.8 (54.7)
18.6	50.9 (58.9)	39.3 (46.3)	30.2 (38.0)
94.4	39.4 (49.4)	28.1 (35.1)	20.8 (27.0)
	NORMAL FORCE[3,4]		
0.015 inch			
10.7	2.2 (0.6 to 4.7)	-0.5 (-2.0 to 1.6)	-2.5 (-3.9 to -0.7)
18.6	1.4 (.8 to 2.6)	-.2 (-1.2 to .8)	-1.9 (-3.0 to -.7)
94.4	.8 (.1 to 1.9)	-.8 (-1.7 to .0)	-1.7 (-2.6 to -.6)
0.030 inch			
10.7	3.2 (.7 to 7.2)	-1.8 (-4.6 to 2.6)	-5.9 (-8.3 to -3.0)
18.6	1.4 (.2 to 3.1)	-2.4 (-4.1 to -.6)	-4.6 (-6.5 to -2.4)
94.4	.5 (-.9 to 1.6)	-2.0 (-3.1 to -.6)	-3.7 (-5.2 to -1.7)
0.045 inch			
10.7	4.5 (.8 to 9.2)	-2.9 (-6.0 to 2.8)	-7.9 (-10.7 to -3.8)
18.6	1.5 (.0 to 3.9)	-3.8 (-5.7 to -1.6)	-6.7 (-8.9 to -3.1)
94.4	.5 (-1.1 to 2.1)	-3.2 (-4.7 to -1.1)	-5.1 (-7.7 to -2.6)
0.060 inch			
10.7	5.7 (1.5 to 10.2)	-2.8 (-7.7 to 4.6)	-10.4 (-14.2 to -4.6)
18.6	1.4 (-.7 to 3.9)	-5.2 (-8.1 to -1.3)	-8.7 (-12.0 to -4.2)
94.4	.3 (-1.9 to 2.2)	-4.3 (-6.3 to -1.6)	-6.6 (-10.0 to -3.2)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five)

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 12A.--TOOL FORCES WHEN ORTHOGONALLY CUTTING NORTHERN RED OAK VENEER IN THE 0-90 DRIECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	50	60	70
	Pounds per 0.1 inch of knife		
	PARALLEL FORCE[2]		
0.015 inch			
10.9	2.9 (9.0)	3.5 (8.6)	3.5 (6.9)
18.1	2.8 (6.6)	2.7 (5.8)	4.8 (11.9)
91.9	2.2 (4.8)	2.1 (4.4)	3.9 (7.6)
0.030 inch			
10.9	4.2 (13.1)	4.2 (12.0)	3.8 (8.6)
18.1	4.2 (9.8)	3.6 (8.3)	3.3 (6.3)
91.9	3.3 (8.3)	3.0 (6.5)	2.6 (5.3)
0.045 inch			
10.9	4.6 (15.0)	5.4 (14.7)	5.3 (10.6)
18.1	4.2 (11.6)	4.4 (10.3)	3.9 (8.3)
91.9	3.6 (9.5)	3.6 (7.3)	3.1 (6.1)
0.060 inch			
10.9	6.2 (18.4)	5.9 (16.4)	5.9 (14.1)
18.1	4.6 (12.6)	5.0 (11.4)	4.6 (9.6)
91.9	4.7 (12.1)	4.1 (8.8)	3.8 (7.3)
	NORMAL FORCE[3,4]		
0.015 inch			
10.9	0.5 (-0.7 to 2.7)	0.9 (-0.4 to 3.0)	0.6 (-0.6 to 1.6)
18.1	.3 (-.7 to 1.9)	.3 (-.8 to 2.0)	1.0 (-1.2 to 4.3)
91.9	.2 (-.5 to 1.3)	.2 (-.4 to .8)	.4 (-1.2 to 1.9)
0.030 inch			
10.9	.5 (-1.1 to 3.8)	.6 (-1.0 to 3.3)	1.4 (-.4 to 3.1)
18.1	.1 (-1.3 to 2.3)	-.1 (-1.5 to 2.0)	.4 (-1.1 to 2.0)
91.9	.0 (-.8 to 1.5)	-.3 (-1.4 to .8)	.4 (-.5 to 1.3)
0.045 inch			
10.9	.8 (-1.1 to 4.2)	.4 (-1.7 to 3.1)	1.7 (-.1 to 4.0)
18.1	.2 (-1.5 to 2.3)	.1 (-2.0 to 2.5)	.1 (-1.7 to 2.3)
91.9	-.1 (-1.2 to 1.7)	-.4 (-1.9 to .8)	-.1 (-1.2 to 1.0)
0.060 inch			
10.9	.6 (-1.4 to 4.6)	.8 (-1.2 to 4.0)	1.8 (-.6 to 5.1)
18.1	-.1 (-1.6 to 2.1)	.1 (-2.4 to 2.9)	-.3 (-1.8 to 1.8)
91.9	.0 (-1.5 to 1.7)	-.7 (-2.7 to .7)	-.4 (-1.7 to 1.1)

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[1] Clearance angle 0°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece

TABLE 12B.--TOOL FORCES WHEN ORTHOGONALLY CUTTING NORTHERN RED OAK PARALLEL TO THE GRAIN IN THE 90-0 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	10	20	30
	Pounds per 0.1 inch of knife		
		PARALLEL FORCE[2]	
0.015 inch			
10.4	20.1 (23.3)	17.6 (19.7)	11.9 (16.0)
17.8	13.6 (15.2)	11.9 (13.4)	8.8 (10.8)
78.9	8.8 (10.1)	8.0 (9.0)	5.8 (7.1)
0.030 inch			
10.4	37.2 (44.9)	31.9 (38.4)	18.9 (31.8)
17.8	25.6 (31.5)	23.4 (25.5)	15.9 (21.0)
78.9	19.9 (22.5)	15.5 (17.0)	10.5 (12.3)
0.045 inch			
10.4	45.2 (58.1)	40.4 (51.7)	21.4 (38.7)
17.8	32.3 (38.2)	32.9 (37.1)	17.8 (27.5)
78.9	27.1 (30.3)	21.1 (23.9)	15.4 (18.1)
0.060 inch			
10.4	58.9 (77.7)	47.3 (70.6)	24.9 (52.4)
17.8	44.0 (54.5)	40.9 (43.8)	20.4 (34.7)
78.9	36.4 (40.9)	27.9 (33.1)	17.5 (22.8)
		NORMAL FORCE[3,4]	
0.015 inch			
10.4	5.6 (4.5 to 6.7)	2.0 (1.4 to 2.5)	-.4 (-0.9 to 0.3)
17.8	3.5 (3.0 to 4.2)	1.3 (.9 to 1.7)	-.4 (-.8 to .1)
78.9	2.6 (1.9 to 3.1)	.9 (.6 to 1.3)	.1 (-.3 to .5)
0.030 inch			
10.4	9.1 (6.8 to 11.8)	3.1 (2.2 to 4.0)	-1.2 (-2.8 to -.1)
17.8	6.4 (4.9 to 7.6)	1.8 (1.1 to 2.4)	-1.3 (-2.0 to -.5)
78.9	4.2 (3.5 to 5.2)	1.0 (.6 to 1.6)	-.8 (-1.2 to -.2)
0.045 inch			
10.4	10.8 (8.1 to 13.5)	3.8 (2.4 to 5.2)	-1.6 (-3.5 to -.1)
17.8	7.7 (5.7 to 8.9)	2.3 (1.6 to 2.9)	-1.5 (-2.6 to -.4)
78.9	6.0 (4.8 to 7.0)	1.1 (.6 to 1.9)	-1.4 (-2.0 to -.6)
0.060 inch			
10.4	13.6 (9.5 to 17.8)	3.7 (1.5 to 5.7)	-2.0 (-4.7 to -.3)
17.8	10.4 (7.7 to 12.7)	2.8 (1.9 to 3.4)	-1.9 (-3.6 to -.5)
78.9	7.3 (5.8 to 8.5)	1.1 (.5 to 1.7)	-1.6 (-2.6 to -.7)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five)

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 12C.--TOOL FORCES WHEN ORTHOGONALLY CUTTING NORTHERN RED OAK ACROSS THE GRAIN IN THE 90-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	20	30	40
	--------------Pounds per 0.1 inch of knife--------------		
	PARALLEL FORCE[2]		
0.015 inch			
10.6	21.8 (27.4)	17.1 (21.7)	17.4 (22.0)
17.8	17.2 (21.3)	14.8 (17.5)	13.0 (16.2)
92.3	12.8 (15.0)	10.6 (13.5)	8.6 (10.9)
0.030 inch			
10.6	34.5 (42.5)	29.4 (40.9)	24.4 (31.3)
17.8	29.9 (36.3)	21.9 (26.3)	18.3 (23.6)
92.3	23.1 (27.4)	18.3 (22.0)	14.0 (17.0)
0.045 inch			
10.6	37.0 (49.8)	35.0 (46.6)	29.3 (36.8)
17.8	41.4 (47.8)	29.6 (36.2)	24.5 (32.7)
92.3	31.3 (37.6)	22.7 (29.1)	17.4 (21.4)
0.060 inch			
10.6	45.0 (56.9)	40.8 (52.9)	36.9 (46.7)
17.8	46.1 (53.3)	36.1 (43.0)	29.2 (35.9)
92.3	36.7 (43.8)	27.6 (32.7)	20.9 (25.5)
	NORMAL FORCE[3,4]		
0.015 inch			
10.6	1.7 (0.6 to 2.9)	-0.3 (-1.5 to 1.2)	-3.5 (-5.2 to -1.7)
17.8	1.3 (.5 to 2.1)	-1.0 (-1.9 to -.1)	-2.6 (-3.8 to -1.2)
92.3	.7 (.2 to 1.3)	-.7 (-1.7 to .1)	-2.0 (-2.8 to -1.0)
0.030 inch			
10.6	2.3 (.5 to 4.2)	-2.0 (-4.1 to 1.2)	-5.6 (-8.0 to -2.7)
17.8	1.4 (-.2 to 2.9)	-2.5 (-3.8 to -1.0)	-4.7 (-6.5 to -2.4)
92.3	.4 (-.5 to 1.4)	-2.2 (-3.3 to -.8)	-4.0 (-5.2 to -2.5)
0.045 inch			
10.6	2.4 (-.2 to 5.4)	-3.0 (-5.7 to -.5)	-7.4 (-10.4 to -3.7)
17.8	1.3 (-.7 to 3.5)	-3.4 (-4.9 to -2.0)	-7.1 (-10.1 to -4.4)
92.3	.7 (-.6 to 1.8)	-3.1 (-4.6 to -1.6)	-5.2 (-7.3 to -3.3)
0.060 inch			
10.6	3.6 (-.1 to 8.2)	-3.6 (-6.6 to -.2)	-9.9 (-13.5 to -6.4)
17.8	1.7 (-.7 to 4.7)	-4.3 (-7.0 to -1.6)	-8.3 (-11.5 to -4.9)
92.3	1.3 (-.5 to 2.9)	-4.0 (-6.0 to -2.2)	-6.8 (-9.0 to -3.8)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 13A.--TOOL FORCES WHEN ORTHOGONALLY CUTTING POST OAK VENEER IN THE 0-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	50	60	70
	Pounds per 0.1 inch of knife		
	PARALLEL FORCE[2]		
0.015 inch			
11.6	3.8 (9.6)	4.0 (8.0)	3.6 (5.9)
19.5	3.0 (6.0)	2.5 (5.1)	5.9 (11.0)
78.5	2.4 (4.3)	2.1 (4.3)	4.8 (8.8)
0.030 inch			
11.6	5.6 (13.4)	5.1 (11.9)	4.6 (9.0)
19.5	4.5 (8.9)	3.8 (7.6)	3.2 (5.4)
78.5	3.4 (6.4)	3.1 (6.5)	2.8 (4.9)
0.045 inch			
11.6	6.2 (17.4)	6.3 (13.7)	5.4 (10.9)
19.5	5.5 (11.1)	4.8 (10.2)	4.4 (7.2)
78.5	4.0 (8.5)	3.7 (8.1)	3.5 (6.2)
0.060 inch			
11.6	7.7 (18.4)	6.6 (17.6)	6.9 (14.4)
19.5	6.5 (12.3)	5.6 (10.7)	5.5 (9.1)
78.5	5.0 (9.5)	4.4 (9.4)	4.0 (7.3)
	NORMAL FORCE[3,4]		
0.015 inch			
11.6	-0.3 (-1.4 to 1.2)	0.2 (-1.0 to 1.3)	-0.6 (-1.6 to 0.8)
19.5	-.3 (-1.2 to 1.4)	-.5 (-1.3 to .9)	-.7 (-2.7 to 1.7)
78.5	-.1 (-.7 to .8)	-.2 (-1.0 to .7)	.0 (-2.0 to 1.9)
0.030 inch			
11.6	-.3 (-2.1 to 1.7)	-.4 (-2.2 to 1.1)	.3 (-1.2 to 1.9)
19.5	-.8 (-2.0 to .5)	-1.1 (-2.2 to .4)	-.5 (-1.4 to .5)
78.5	-.6 (-1.4 to .4)	-.8 (-1.8 to .2)	.1 (-.6 to .9)
0.045 inch			
11.6	-.7 (-2.6 to 1.8)	-.9 (-3.0 to 1.2)	-.3 (-2.3 to 1.3)
19.5	-1.1 (-2.5 to .6)	-1.6 (-3.2 to .3)	-1.4 (-2.7 to .3)
78.5	-.8 (-2.1 to .4)	-1.1 (-2.5 to .3)	-.6 (-1.5 to 1.0)
0.060 inch			
11.6	-.9 (-3.4 to 1.4)	-1.0 (-3.9 to 1.9)	-.7 (-2.8 to 2.1)
19.5	-1.2 (-3.2 to .7)	-1.9 (-3.6 to .0)	-1.6 (-3.6 to .8)
78.5	-1.1 (-2.9 to .4)	-1.2 (-2.9 to .5)	-.9 (-2.2 to .7)

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[1] Clearance angle 0°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five)

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece

TABLE 13B.--TOOL FORCES WHEN ORTHOGONALLY CUTTING POST OAK PARALLEL TO THE GRAIN IN THE 90-0 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	10	20	30
	Pounds per 0.1 inch of knife		
		PARALLEL FORCE[2]	
0.015 inch			
11.3	18.0 (20.3)	16.7 (20.4)	10.2 (13.6)
19.7	12.1 (14.1)	9.9 (11.2)	5.9 (7.4)
79.6	8.8 (10.8)	7.4 (8.7)	4.9 (5.9)
0.030 inch			
11.3	32.6 (40.4)	31.8 (36.1)	15.3 (22.1)
19.7	22.3 (26.8)	17.2 (20.1)	10.7 (14.3)
79.6	17.4 (21.4)	11.6 (14.1)	7.0 (9.7)
0.045 inch			
11.3	40.8 (55.9)	38.9 (46.9)	19.4 (36.5)
19.7	31.6 (38.0)	24.0 (27.5)	13.0 (15.2)
79.6	23.8 (31.5)	15.8 (19.3)	9.5 (12.3)
0.060 inch			
11.3	52.3 (73.2)	45.9 (57.7)	21.2 (40.7)
19.7	38.3 (50.1)	28.8 (35.0)	15.5 (21.0)
79.6	29.8 (38.0)	18.0 (23.6)	12.4 (15.4)
		NORMAL FORCE[3,4]	
0.015 inch			
11.3	4.8 (3.5 to 5.8)	1.8 (1.3 to 2.4)	-0.6 (-1.1 to 0.0)
19.7	3.5 (2.6 to 4.1)	1.2 (.8 to 1.6)	.1 (-.6 to .8)
79.6	2.4 (1.7 to 3.1)	.8 (.5 to 1.3)	.0 (-.3 to .4)
0.030 inch			
11.3	8.2 (5.8 to 10.7)	2.9 (2.0 to 3.7)	-1.1 (-2.0 to .1)
19.7	5.4 (4.0 to 6.6)	1.6 (1.0 to 2.0)	-.8 (-1.4 to -.2)
79.6	4.1 (3.0 to 5.3)	1.1 (.6 to 1.6)	-.4 (-.8 to .3)
0.045 inch			
11.3	10.3 (6.9 to 13.5)	3.4 (2.0 to 4.6)	-1.5 (-3.2 to -.4)
19.7	7.4 (5.4 to 9.2)	2.0 (1.3 to 2.6)	-1.1 (-1.5 to -.4)
79.6	5.0 (3.4 to 6.1)	1.3 (.6 to 1.9)	-.5 (-1.0 to .2)
0.060 inch			
11.3	11.8 (7.6 to 18.1)	3.9 (1.9 to 5.6)	-1.7 (-4.1 to .1)
19.7	8.8 (5.8 to 11.5)	2.0 (1.3 to 2.8)	-1.3 (-1.9 to -.6)
79.6	6.1 (4.2 to 7.5)	1.4 (.9 to 2.1)	-.6 (-1.3 to .1)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 13C.--TOOL FORCES WHEN ORTHOGONALLY CUTTING POST OAK ACROSS THE GRAIN IN THE 90-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	20	30	40
	Pounds per 0.1 inch of knife		
		PARALLEL FORCE[2]	
0.015 inch			
10.0	24.5 (32.1)	18.0 (23.3)	17.1 (22.1)
19.5	16.4 (20.6)	14.1 (18.1)	9.7 (12.5)
83.1	15.4 (18.5)	11.4 (14.1)	8.5 (11.2)
0.030 inch			
10.0	40.7 (50.1)	35.2 (44.5)	28.5 (38.1)
19.5	31.2 (38.0)	23.0 (29.1)	17.2 (22.1)
83.1	23.6 (27.5)	18.3 (21.9)	13.7 (17.3)
0.045 inch			
10.0	48.3 (61.1)	43.4 (56.4)	36.2 (48.0)
19.5	39.2 (48.0)	31.4 (39.1)	23.0 (30.1)
83.1	34.7 (41.4)	23.1 (29.3)	18.4 (22.9)
0.060 inch			
10.0	51.2 (65.2)	51.3 (67.6)	45.0 (60.1)
19.5	45.9 (55.0)	37.7 (45.4)	28.5 (36.4)
83.1	41.6 (50.6)	29.2 (34.6)	22.1 (29.0)
		NORMAL FORCE[3,4]	
0.015 inch			
10.0	1.6 (0.2 to 4.3)	-0.8 (-2.0 to 0.8)	-3.2 (-5.0 to -1.3)
19.5	1.1 (.3 to 1.8)	-.9 (-1.9 to .8)	-2.0 (-3.0 to -.9)
83.1	.5 (-.1 to 1.2)	-.9 (-1.6 to -.2)	-2.1 (-3.0 to -.9)
0.030 inch			
10.0	1.3 (-.9 to 4.7)	-4.2 (-6.5 to -.9)	-7.6 (-11.4 to -4.6)
19.5	.8 (-.6 to 2.6)	-2.6 (-4.7 to -.3)	-4.6 (-6.3 to -2.3)
83.1	.3 (-.5 to 1.2)	-2.4 (-3.5 to -.9)	-4.1 (-5.6 to -2.4)
0.045 inch			
10.0	1.5 (-1.5 to 7.5)	-5.6 (-8.4 to -.9)	-10.7 (-15.0 to -6.6)
19.5	.9 (-.9 to 3.4)	-4.0 (-6.5 to -.7)	-6.8 (-9.6 to -3.8)
83.1	.2 (-1.7 to 1.7)	-3.4 (-5.2 to -1.8)	-5.7 (-7.6 to -3.3)
0.060 inch			
10.0	2.0 (-2.6 to 7.8)	-7.4 (-11.9 to -2.5)	-13.7 (-19.4 to -7.1)
19.5	1.3 (-1.4 to 4.3)	-5.3 (-8.3 to -2.0)	-8.6 (-12.4 to -4.7)
83.1	.3 (-2.1 to 2.7)	-4.5 (-6.6 to -2.5)	-6.8 (-9.6 to -4.0)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 14A.--TOOL FORCES WHEN ORTHOGONALLY CUTTING SCARLET OAK VENEER IN THE 0-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	50	60	70
	Pounds per 0.1 inch of knife		
	PARALLEL FORCE[2]		
0.015 inch			
11.0	3.8 (11.9)	4.8 (10.3)	4.2 (8.5)
18.8	3.1 (6.8)	3.0 (5.5)	5.6 (11.2)
92.3	2.2 (5.0)	2.4 (5.3)	2.3 (4.5)
0.030 inch			
11.0	5.1 (15.1)	5.4 (14.1)	5.1 (12.5)
18.8	4.3 (9.5)	4.1 (8.7)	3.7 (6.8)
92.3	3.3 (7.2)	3.4 (7.3)	2.9 (5.7)
0.045 inch			
11.0	5.7 (16.5)	6.3 (17.7)	5.9 (13.0)
18.8	4.9 (11.5)	5.0 (10.7)	4.5 (9.2)
92.3	3.9 (7.9)	3.5 (7.6)	3.5 (7.1)
0.060 inch			
11.0	6.8 (19.2)	7.3 (17.2)	7.4 (16.9)
18.8	6.0 (13.4)	5.6 (12.7)	5.2 (10.5)
92.3	4.5 (9.7)	3.9 (8.6)	3.9 (7.7)
	NORMAL FORCE[3,4]		
0.015 inch			
11.0	1.1 (-1.2 to 4.5)	1.5 (-0.2 to 3.7)	0.7 (-0.6 to 2.0)
18.8	.4 (-.8 to 2.3)	.5 (-1.0 to 2.8)	.2 (-1.8 to 2.8)
92.3	.1 (-.6 to 1.0)	-.2 (-1.1 to 1.0)	.3 (-.4 to 1.6)
0.030 inch			
11.0	.3 (-1.7 to 5.5)	.6 (-1.9 to 5.0)	.9 (-1.5 to 3.8)
18.8	-.1 (-1.7 to 2.5)	-.4 (-2.0 to 1.3)	-.1 (-1.4 to 1.8)
92.3	-.3 (-1.4 to 1.3)	-.8 (-2.0 to .8)	-.4 (-1.4 to .8)
0.045 inch			
11.0	.5 (-1.6 to 5.6)	.7 (-1.8 to 5.2)	.9 (-1.6 to 4.1)
18.8	-.2 (-1.9 to 2.0)	-.8 (-2.9 to 1.3)	-1.1 (-2.9 to 1.3)
92.3	-.4 (-1.9 to 1.2)	-1.1 (-2.7 to .5)	-.8 (-2.2 to .5)
0.060 inch			
11.0	.7 (-1.9 to 5.4)	1.2 (-2.4 to 5.2)	.7 (-2.1 to 4.9)
18.8	-.2 (-2.2 to 2.8)	-1.2 (-3.8 to 1.5)	-1.5 (-3.5 to 1.0)
92.3	-.4 (-2.3 to 1.5)	-1.0 (-2.9 to .8)	-.9 (-2.6 to .8)

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[1] Clearance angle 0°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 14B.--TOOL FORCES WHEN ORTHOGONALLY CUTTING SCARLET OAK PARALLEL TO THE GRAIN IN THE 90-0 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	10	20	30
	Pounds per 0.1 inch of knife		
		PARALLEL FORCE[2]	
0.015 inch			
10.3	19.8 (23.8)	15.4 (18.8)	10.4 (16.0)
18.2	11.4 (13.1)	9.1 (10.8)	7.4 (9.2)
88.7	8.9 (11.2)	7.1 (8.6)	4.6 (5.7)
0.030 inch			
10.3	34.6 (41.9)	28.5 (36.2)	15.2 (27.0)
18.2	24.5 (29.0)	20.1 (23.2)	13.9 (18.1)
88.7	17.0 (19.8)	12.7 (15.6)	7.8 (10.5)
0.045 inch			
10.3	44.5 (59.2)	38.8 (50.5)	18.2 (38.7)
18.2	29.8 (36.3)	22.3 (30.6)	19.7 (23.1)
88.7	22.4 (27.9)	17.6 (21.7)	10.3 (15.4)
0.060 inch			
10.3	54.4 (74.3)	50.9 (64.7)	25.7 (51.7)
18.2	42.8 (49.7)	35.8 (38.7)	21.8 (26.7)
88.7	28.6 (36.9)	21.6 (26.2)	11.9 (11.5)
		NORMAL FORCE[3,4]	
0.015 inch			
10.3	5.7 (4.3 to 7.3)	1.9 (1.2 to 3.4)	-0.4 (-1.0 to 0.6)
18.2	3.1 (2.3 to 4.1)	1.1 (.6 to 1.5)	-.1 (-.6 to .4)
88.7	2.7 (1.8 to 4.1)	1.0 (.5 to 1.5)	.4 (-.3 to .8)
0.030 inch			
10.3	8.4 (6.0 to 10.9)	2.9 (1.6 to 4.1)	-1.1 (-2.1 to .2)
18.2	6.2 (5.0 to 7.4)	1.9 (1.2 to 2.4)	-.9 (-1.5 to -.2)
88.7	4.1 (3.1 to 5.4)	1.2 (.6 to 2.0)	-.3 (-.8 to .3)
0.045 inch			
10.3	11.0 (7.3 to 14.3)	4.0 (2.6 to 5.3)	-1.3 (-3.3 to .2)
18.2	7.4 (5.4 to 9.0)	1.8 (1.1 to 2.9)	-1.8 (-2.3 to -1.0)
88.7	5.0 (3.7 to 6.8)	1.3 (.6 to 2.1)	-.8 (-1.4 to .0)
0.060 inch			
10.3	12.4 (8.2 to 19.1)	5.0 (3.3 to 6.6)	-1.6 (-4.4 to .9)
18.2	9.8 (7.0 to 11.5)	2.7 (1.8 to 3.2)	-2.0 (-2.6 to -1.2)
88.7	6.4 (3.8 to 8.5)	1.3 (.6 to 2.4)	-1.0 (-1.9 to -.2)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 14C.--TOOL FORCES WHEN ORTHOGONALLY CUTTING SCARLET OAK ACROSS THE GRAIN IN THE 90-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	20	30	40
	Pounds per 0.1 inch of knife		
	PARALLEL FORCE[2]		
0.015 inch			
10.6	23.0 (31.3)	21.4 (28.5)	17.2 (21.8)
18.2	17.3 (20.8)	14.6 (17.8)	11.8 (15.8)
94.5	14.1 (17.5)	10.1 (12.2)	9.6 (12.0)
0.030 inch			
10.6	38.1 (49.2)	35.4 (44.5)	27.1 (34.9)
18.2	29.8 (36.8)	21.5 (25.8)	18.6 (23.3)
94.5	23.7 (27.7)	17.0 (21.0)	14.2 (18.3)
0.045 inch			
10.6	41.3 (54.0)	39.8 (50.2)	34.5 (43.5)
18.2	39.5 (44.8)	29.3 (35.3)	23.0 (29.7)
94.5	30.4 (36.7)	21.1 (26.4)	18.1 (23.3)
0.060 inch			
10.6	47.5 (64.1)	46.9 (60.7)	43.1 (53.5)
18.2	47.1 (57.0)	32.8 (43.6)	27.9 (39.1)
94.5	34.3 (40.3)	26.9 (33.1)	22.0 (28.5)
	NORMAL FORCE[3,4]		
0.015 inch			
10.6	1.9 (0.7 to 4.3)	-1.1 (-2.6 to 1.5)	-3.3 (-4.8 to -1.6)
18.2	1.2 (.2 to 2.1)	-1.2 (-2.0 to .3)	-2.4 (-3.6 to -1.0)
94.5	.5 (-.2 to 1.1)	-.6 (-1.4 to .0)	-2.2 (-3.3 to -1.2)
0.030 inch			
10.6	2.9 (.9 to 5.4)	-3.1 (-5.0 to -.4)	-6.4 (-8.9 to -3.0)
18.2	1.0 (-.2 to 2.2)	-2.7 (-4.2 to -.9)	-5.0 (-6.6 to -3.0)
94.5	.3 (-1.0 to 1.3)	-2.1 (-3.2 to -.8)	-4.0 (-5.9 to -2.3)
0.045 inch			
10.6	3.9 (-.5 to 8.3)	-3.2 (-6.2 to .3)	-8.8 (-11.8 to -4.9)
18.2	1.1 (-.6 to 2.7)	-4.2 (-6.6 to -1.6)	-6.9 (-9.5 to -3.5)
94.5	.5 (-1.0 to 1.8)	-2.9 (-4.6 to -1.5)	-5.6 (-8.1 to -3.5)
0.060 inch			
10.6	4.7 (.6 to 9.7)	-4.0 (-8.2 to 3.3)	-11.7 (-16.0 to -5.2)
18.2	1.4 (-1.2 to 3.7)	-5.5 (-9.1 to -2.2)	-9.2 (-12.9 to -3.5)
94.5	.8 (-.8 to 2.3)	-4.2 (-6.3 to -2.2)	-7.8 (-10.3 to -4.5)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 15A.--TOOL FORCES WHEN ORTHOGONALLY CUTTING SHUMARD OAK VENEER IN THE 0-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	50	60	70
	Pounds per 0.1 inch of knife		
	PARALLEL FORCE[2]		
0.015 inch			
11.0	4.0 (9.1)	3.9 (8.7)	4.4 (9.2)
18.4	3.1 (5.6)	5.5 (12.5)	3.0 (5.7)
92.5	2.4 (5.4)	4.9 (9.3)	2.6 (4.5)
0.030 inch			
11.0	5.2 (15.0)	4.5 (8.8)	5.3 (10.8)
18.4	4.2 (9.1)	3.3 (6.4)	3.9 (7.6)
92.5	3.5 (8.4)	2.8 (5.9)	3.3 (6.3)
0.045 inch			
11.0	5.8 (16.8)	5.7 (12.9)	5.9 (13.3)
18.4	5.6 (11.4)	4.1 (8.6)	4.8 (9.0)
92.5	4.0 (9.6)	3.9 (8.4)	3.5 (7.4)
0.060 inch			
11.0	6.7 (18.5)	6.0 (15.2)	6.5 (15.8)
18.4	6.3 (13.0)	4.8 (10.0)	5.4 (10.3)
92.5	4.7 (12.1)	4.3 (9.2)	4.4 (8.4)
	NORMAL FORCE[3,4]		
0.015 inch			
11.0	0.8 (-1.1 to 3.6)	-0.5 (-2.4 to 1.4)	1.5 (-0.4 to 3.8)
18.4	.3 (-.7 to 1.8)	.4 (-1.5 to 3.0)	.6 (-.8 to 2.0)
92.5	.6 (-.4 to 2.3)	.1 (-1.4 to 1.9)	.8 (-.2 to 1.8)
0.030 inch			
11.0	.3 (-1.8 to 4.0)	1.2 (-.6 to 3.1)	.9 (-1.0 to 3.5)
18.4	-.4 (-1.5 to 2.1)	-.4 (-1.6 to 1.2)	.0 (-1.7 to 2.1)
92.5	.3 (-1.2 to 2.0)	.1 (-1.2 to 1.5)	.4 (-.7 to 1.6)
0.045 inch			
11.0	.4 (-1.8 to 5.0)	.6 (-1.3 to 3.1)	.4 (-1.4 to 3.0)
18.4	-.7 (-1.9 to 1.7)	-.4 (-2.1 to 1.8)	-.6 (-2.2 to 1.4)
92.5	.1 (-1.1 to 2.4)	-.2 (-1.9 to 2.0)	.1 (-1.4 to 1.7)
0.060 inch			
11.0	.5 (-2.1 to 4.6)	.3 (-1.7 to 3.0)	.5 (-1.9 to 3.8)
18.4	-.7 (-2.3 to 1.9)	-.6 (-2.6 to 1.6)	-.4 (-2.3 to 1.7)
92.5	.2 (-1.1 to 2.3)	-.5 (-2.6 to 1.8)	-.2 (-1.9 to 1.4)

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[1] Clearance angle 0°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five)

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 15B.--TOOL FORCES WHEN ORTHOGONALLY CUTTING SHUMARD OAK PARALLEL TO THE GRAIN IN THE 90-0 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	10	20	30
	Pounds per 0.1 inch of knife		
	PARALLEL FORCE[2]		
0.015 inch			
10.4	19.7 (23.1)	17.4 (21.5)	11.6 (16.6)
18.8	12.3 (14.2)	8.8 (11.5)	7.3 (8.9)
88.0	9.3 (10.7)	7.0 (7.9)	4.6 (6.3)
0.030 inch			
10.4	35.8 (45.0)	29.1 (40.9)	16.5 (31.0)
18.8	24.5 (28.3)	20.5 (23.7)	13.8 (17.1)
88.0	17.7 (20.6)	13.3 (15.5)	8.3 (10.5)
0.045 inch			
10.4	43.7 (55.6)	40.1 (52.7)	20.8 (39.9)
18.8	32.5 (36.6)	25.5 (29.0)	18.4 (23.0)
88.0	25.5 (30.3)	19.2 (22.0)	11.4 (14.2)
0.060 inch			
10.4	51.2 (72.3)	47.2 (70.1)	20.3 (47.4)
18.8	40.3 (49.1)	34.3 (38.1)	21.0 (27.6)
88.0	31.1 (37.1)	24.8 (28.5)	14.8 (18.5)
	NORMAL FORCE[3,4]		
0.015 inch			
10.4	5.6 (4.3 to 6.5)	2.3 (1.6 to 2.8)	-0.2 (-0.8 to 0.3)
18.8	3.7 (2.5 to 4.7)	1.1 (.7 to 1.6)	-.1 (-.5 to .3)
88.0	2.6 (2.2 to 3.1)	1.1 (.7 to 1.4)	.3 (-.1 to .7)
0.030 inch			
10.4	9.6 (7.4 to 11.6)	3.5 (2.0 to 4.6)	-.9 (-2.0 to .0)
18.8	6.3 (5.4 to 7.3)	1.9 (1.3 to 2.7)	-.9 (-1.4 to -.4)
88.0	4.3 (3.5 to 4.9)	1.4 (.8 to 1.9)	-.2 (-.6 to .3)
0.045 inch			
10.4	11.2 (8.9 to 13.7)	4.1 (2.6 to 5.4)	-1.1 (-3.2 to .2)
18.8	7.9 (6.4 to 8.9)	2.3 (1.5 to 3.0)	-1.4 (-2.0 to -.5)
88.0	5.9 (4.7 to 7.0)	1.5 (1.0 to 1.8)	-.6 (-1.1 to .1)
0.060 inch			
10.4	12.5 (8.4 to 17.3)	4.4 (2.3 to 6.5)	-1.2 (-3.6 to .3)
18.8	9.8 (6.7 to 11.5)	3.0 (2.2 to 3.7)	-1.7 (-2.6 to -.7)
88.0	7.1 (5.2 to 8.4)	1.6 (.9 to 2.2)	-.7 (-1.6 to .4)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 15C.--TOOL FORCES WHEN ORTHOGONALLY CUTTING SHUMARD OAK ACROSS THE GRAIN IN THE 90-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	20	30	40
	--------------*Pounds per 0.1 inch of knife*	--------------	
		PARALLEL FORCE[2]	
0.015 inch			
10.4	28.6 (36.8)	20.0 (25.7)	16.6 (21.9)
17.5	18.2 (21.7)	14.0 (18.7)	11.3 (14.2)
90.8	13.6 (15.8)	11.8 (13.8)	9.5 (11.3)
0.030 inch			
10.4	41.0 (51.2)	36.8 (43.0)	26.5 (33.2)
17.5	30.6 (36.7)	23.0 (27.6)	17.3 (22.4)
90.8	24.5 (29.3)	18.0 (20.8)	14.7 (17.3)
0.045 inch			
10.4	48.8 (59.1)	42.4 (53.0)	33.9 (42.5)
17.5	38.6 (44.7)	29.9 (36.2)	23.3 (30.2)
90.8	31.2 (36.5)	23.7 (27.4)	18.6 (21.9)
0.060 inch			
10.4	59.1 (75.8)	52.2 (68.5)	40.2 (53.2)
17.5	45.5 (53.5)	35.3 (43.9)	26.9 (35.9)
90.8	36.9 (42.1)	28.8 (33.1)	22.3 (26.8)
		NORMAL FORCE[3,4]	
0.015 inch			
10.4	1.9 (0.4 to 3.4)	-0.6 (-1.8 to 0.7)	-3.3 (-4.6 to -2.1)
17.5	1.4 (.8 to 2.0)	-.9 (-2.2 to .0)	-2.1 (-3.1 to -1.2)
90.8	.7 (.1 to 1.2)	-.8 (-1.4 to -.2)	-2.0 (-2.9 to -1.2)
0.030 inch			
10.4	2.4 (.5 to 4.5)	-3.4 (-5.2 to -.6)	-6.3 (-8.8 to -3.6)
17.5	1.4 (.2 to 2.8)	-2.3 (-4.1 to -.9)	-4.5 (-6.3 to -2.7)
90.8	5 (-.4 to 1.6)	-2.0 (-3.0 to -1.0)	-4.0 (-5.4 to -2.6)
0.045 inch			
10.4	3.0 (.5 to 6.1)	-4.0 (-7.0 to -1.3)	-8.9 (-12.1 to -5.1)
17.5	1.2 (-.3 to 3.2)	-3.7 (-5.9 to -2.0)	-6.7 (-9.9 to -3.4)
90.8	.6 (-.8 to 1.8)	-3.1 (-4.5 to -1.6)	-5.7 (-7.4 to -3.9)
0.060 inch			
10.4	3.7 (.9 to 7.4)	-5.5 (-9.4 to -1.4)	-11.5 (-14.7 to -6.4)
17.5	1.5 (-.2 to 4.1)	-4.7 (-7.1 to -2.4)	-8.4 (-12.5 to -3.9)
90.8	1.1 (-.5 to 2.6)	-4.3 (-6.3 to -2.1)	-7.2 (-9.7 to -4.7)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 16A.--TOOL FORCES WHEN ORTHOGONALLY CUTTING SOUTHERN RED OAK VENEER IN THE 0-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees 50	60	70
	Pounds per 0.1 inch of knife		
	PARALLEL FORCE[2]		
0.015 inch			
11.2	4.4 (11.0)	4.7 (10.6)	4.1 (7.5)
19.4	3.1 (7.6)	2.6 (5.0)	6.1 (12.9)
91.3	2.4 (5.2)	2.2 (4.5)	4.6 (7.9)
0.030 inch			
11.2	6.1 (16.3)	6.4 (14.5)	4.7 (10.0)
19.4	4.6 (10.2)	3.8 (7.5)	3.4 (6.1)
91.3	3.8 (8.2)	3.4 (7.6)	2.5 (5.1)
0.045 inch			
11.2	7.1 (18.8)	7.2 (15.2)	6.1 (12.3)
19.4	5.5 (11.8)	5.3 (11.1)	4.2 (7.4)
91.3	4.2 (10.1)	4.0 (8.6)	3.3 (7.1)
0.060 inch			
11.2	7.8 (21.9)	8.1 (18.1)	6.4 (14.1)
19.4	6.3 (13.2)	6.0 (11.9)	4.9 (8.4)
91.3	4.8 (11.8)	4.7 (9.7)	4.0 (7.8)
	NORMAL FORCE[3,4]		
0.015 inch			
11.2	0.4 (-1.1 to 3.0)	0.8 (-0.9 to 2.3)	-0.4 (-2.2 to 0.9)
19.4	.0 (-1.1 to 2.0)	-.3 (-1.1 to .8)	.5 (-2.1 to 3.9)
91.3	.1 (-.5 to 1.2)	-.1 (-1.0 to .9)	-.5 (-2.1 to .8)
0.030 inch			
11.2	.2 (-1.5 to 2.7)	.3 (-1.9 to 3.1)	.3 (-1.5 to 1.7)
19.4	-.5 (-1.8 to 1.6)	-1.2 (-2.4 to .1)	-.1 (-1.3 to 1.1)
91.3	-.3 (-1.6 to 1.3)	-.8 (-2.1 to .8)	.1 (-1.0 to 1.1)
0.045 inch			
11.2	.3 (-3.0 to 4.9)	-.1 (-2.7 to 3.1)	.2 (-2.0 to 2.5)
19.4	-.9 (-2.5 to 1.1)	-1.2 (-3.3 to 1.1)	-1.1 (-2.3 to .4)
91.3	-.4 (-1.6 to 1.1)	-.7 (-2.9 to 1.2)	-.3 (-1.5 to .9)
0.060 inch			
11.2	.8 (-2.3 to 6.5)	-.2 (-3.7 to 3.0)	-.8 (-3.4 to 1.8)
19.4	-1.0 (-3.1 to .7)	-1.5 (-4.1 to 1.2)	-1.6 (-2.8 to .1)
91.3	-.2 (-1.7 to 1.5)	-1.2 (-3.3 to 1.2)	-1.1 (-2.6 to .4)

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[1] Clearance angle 0°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 16B.--TOOL FORCES WHEN ORTHOGONALLY CUTTING SOUTHERN RED OAK PARALLEL TO THE GRAIN IN THE 90-0 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	10	20	30
	Pounds per 0.1 inch of knife		
		PARALLEL FORCE[2]	
0.015 inch			
10.9	18.1 (23.1)	14.8 (18.4)	12.6 (16.0)
19.5	12.1 (14.6)	9.6 (11.2)	7.1 (9.1)
89.1	10.1 (11.9)	8.1 (9.5)	5.5 (7.3)
0.030 inch			
10.9	38.0 (47.8)	32.8 (38.3)	21.5 (28.9)
19.5	22.5 (27.4)	19.1 (21.6)	11.4 (13.7)
89.1	18.9 (22.6)	14.2 (17.1)	8.9 (13.5)
0.045 inch			
10.9	47.7 (61.4)	42.4 (48.4)	23.3 (38.2)
19.5	31.9 (38.2)	25.1 (29.5)	13.4 (17.0)
89.1	25.4 (30.7)	18.3 (21.0)	11.8 (17.6)
0.060 inch			
10.9	54.8 (70.2)	53.3 (63.7)	24.3 (49.3)
19.5	40.5 (48.6)	30.4 (36.6)	15.4 (20.9)
89.1	31.6 (38.9)	22.9 (30.5)	13.4 (20.2)
		NORMAL FORCE[3,4]	
0.015 inch			
10.9	5.7 (4.3 to 6.7)	1.8 (1.4 to 2.3)	-0.5 (-1.1 to 0.2)
19.5	3.1 (2.2 to 4.0)	1.1 (.8 to 1.6)	-.3 (-.6 to .1)
89.1	2.9 (2.0 to 3.9)	1.0 (.6 to 1.4)	.1 (-.3 to .6)
0.030 inch			
10.9	10.2 (7.7 to 13.4)	3.1 (1.9 to 3.8)	-1.3 (-2.3 to -.3)
19.5	5.5 (3.8 to 6.6)	1.7 (1.2 to 2.2)	-.7 (-1.1 to .0)
89.1	4.5 (3.2 to 5.5)	1.2 (.7 to 1.7)	-.4 (-.9 to .6)
0.045 inch			
10.9	12.1 (8.3 to 15.6)	3.9 (2.7 to 4.9)	-1.5 (-3.1 to -.4)
19.5	7.2 (5.1 to 8.6)	2.0 (1.3 to 2.8)	-.8 (-1.4 to -.1)
89.1	6.0 (4.4 to 7.5)	1.4 (.8 to 2.1)	-.7 (-1.7 to .4)
0.060 inch			
10.9	14.1 (8.7 to 17.9)	4.7 (2.4 to 6.4)	-1.4 (-3.4 to .3)
19.5	9.3 (7.2 to 10.7)	2.5 (1.7 to 3.2)	-1.1 (-2.0 to -.2)
89.1	7.3 (5.4 to 9.7)	1.5 (1.0 to 2.3)	-.9 (-1.9 to .0)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 16C.--TOOL FORCES WHEN ORTHOGONALLY CUTTING SOUTHERN RED OAK ACROSS THE GRAIN IN THE 90-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	20	30	40
	Pounds per 0.1 inch of knife		
		PARALLEL FORCE[2]	
0.015 inch			
10.6	25.4 (33.0)	21.0 (26.3)	17.5 (23.7)
18.7	13.7 (18.4)	13.2 (16.7)	10.8 (13.8)
91.9	14.5 (17.5)	11.0 (14.0)	8.9 (11.5)
0.030 inch			
10.6	43.0 (52.5)	37.0 (46.6)	26.9 (33.8)
18.7	31.0 (36.7)	25.7 (30.7)	18.9 (22.5)
91.9	25.3 (30.2)	17.1 (21.9)	14.0 (17.7)
0.045 inch			
10.6	54.5 (65.4)	43.1 (52.3)	36.0 (47.2)
18.7	39.6 (46.0)	30.2 (37.6)	23.1 (30.5)
91.9	36.0 (43.3)	23.6 (29.2)	18.2 (23.4)
0.060 inch			
10.6	59.3 (73.0)	50.9 (64.2)	42.3 (53.6)
18.7	44.1 (52.8)	39.4 (50.9)	28.4 (37.3)
91.9	39.2 (49.6)	29.5 (40.1)	21.1 (28.5)
		NORMAL FORCE[3,4]	
0.015 inch			
10.6	2.2 (0.9 to 3.8)	-1.1 (-2.3 to 0.6)	-3.7 (-5.5 to -1.5)
18.7	1.1 (.4 to 2.6)	-.8 (-1.6 to .4)	-2.0 (-2.9 to -1.1)
91.9	.5 (.0 to 1.1)	-.7 (-1.6 to .2)	-2.0 (-2.8 to -1.0)
0.030 inch			
10.6	2.9 (1.3 to 6.1)	-3.0 (-5.6 to -.6)	-6.7 (-9.2 to -3.3)
18.7	1.0 (-.1 to 2.8)	-2.6 (-4.6 to -.9)	-4.8 (-6.5 to -2.9)
91.9	.5 (-.4 to 1.5)	-2.0 (-3.3 to -.7)	-3.9 (-5.5 to -2.2)
0.045 inch			
10.6	3.4 (.0 to 7.2)	-4.1 (-6.5 to -.2)	-9.4 (-13.4 to -4.1)
18.7	1.3 (-.6 to 4.0)	-3.9 (-6.4 to .6)	-6.6 (-9.6 to -3.2)
91.9	.6 (-1.2 to 2.2)	-3.2 (-5.0 to -1.4)	-5.4 (-7.9 to -3.0)
0.060 inch			
10.6	4.8 (.0 to 11.6)	-5.0 (-9.1 to -1.3)	-11.0 (-15.5 to -2.1)
18.7	1.4 (-1.0 to 4.9)	-5.5 (-9.4 to -1.0)	-8.5 (-13.0 to -3.6)
91.9	1.3 (-.8 to 3.1)	-4.7 (-6.7 to -1.8)	-7.0 (-9.9 to -3.2)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 17A.--TOOL FORCES WHEN ORTHOGONALLY CUTTING WATER OAK VENEER IN THE 0-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	50	60	70
	Pounds per 0.1 inch of knife		
		PARALLEL FORCE[2]	
0.015 inch			
10.7	3.7 (9.5)	3.3 (7.3)	4.2 (7.9)
18.7	2.8 (6.9)	2.5 (5.5)	4.5 (10.6)
102.6	1.9 (4.8)	1.8 (4.0)	3.7 (6.9)
0.030 inch			
10.7	4.5 (13.4)	4.1 (9.5)	3.7 (8.6)
18.7	3.9 (9.1)	3.3 (7.4)	2.8 (6.0)
102.6	3.0 (6.8)	2.9 (5.7)	2.2 (4.6)
0.045 inch			
10.7	6.0 (16.6)	4.7 (11.6)	4.7 (11.1)
18.7	4.8 (10.4)	4.6 (9.6)	3.4 (7.1)
102.6	3.5 (8.1)	3.3 (6.9)	3.0 (5.5)
0.060 inch			
10.7	6.7 (18.0)	5.6 (13.7)	5.0 (12.3)
18.7	5.2 (11.7)	5.1 (10.2)	4.3 (8.7)
102.6	3.9 (9.6)	3.7 (8.5)	3.4 (6.5)
		NORMAL FORCE[3,4]	
0.015 inch			
10.7	0.8 (-0.7 to 3.2)	0.4 (-0.8 to 1.3)	0.0 (-1.9 to 2.0)
18.7	.5 (-.7 to 2.5)	-.1 (-1.0 to 1.2)	-.1 (-1.9 to 1.6)
102.6	.2 (-.5 to 1.7)	-.1 (-.8 to .4)	-.4 (-2.0 to 1.1)
0.030 inch			
10.7	.4 (-1.1 to 3.5)	-.2 (-1.6 to 1.4)	.8 (-.9 to 2.6)
18.7	-.1 (-1.4 to 2.0)	-.4 (-1.9 to 1.3)	-.2 (-1.2 to 1.6)
102.6	-.1 (-1.1 to 1.7)	-.6 (-1.6 to .6)	.1 (-.6 to 1.2)
0.045 inch			
10.7	.4 (-1.6 to 3.0)	-.3 (-2.3 to 1.5)	.0 (-1.8 to 2.4)
18.7	-.4 (-2.0 to 1.8)	-.7 (-2.5 to 1.2)	-.5 (-1.8 to 1.1)
102.6	-.1 (-1.5 to 1.9)	-.7 (-2.1 to .7)	-.3 (-1.6 to .7)
0.060 inch			
10.7	.5 (-2.3 to 4.1)	-.4 (-2.3 to 1.4)	-.3 (-2.6 to 2.4)
18.7	-.8 (-2.6 to 2.0)	-1.2 (-3.3 to .6)	-.7 (-2.2 to 1.5)
102.6	-.2 (-1.8 to 1.6)	-.8 (-2.8 to 1.2)	-.4 (-1.8 to 1.1)

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[1] Clearance angle 0°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 17B.--TOOL FORCES WHEN ORTHOGONALLY CUTTING WATER OAK PARALLEL TO THE GRAIN IN THE 90-0 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	10	20	30
	Pounds per 0.1 inch of knife		
		PARALLEL FORCE[2]	
0.015 inch			
10.4	20.6 (25.7)	17.7 (20.1)	11.6 (15.6)
18.4	13.6 (14.9)	12.2 (14.0)	8.3 (10.0)
95.5	9.6 (11.0)	7.0 (8.7)	5.8 (7.5)
0.030 inch			
10.4	34.9 (41.8)	35.7 (40.1)	17.0 (32.1)
18.4	25.2 (29.4)	22.6 (25.2)	16.1 (19.7)
95.5	17.7 (20.8)	14.0 (16.3)	10.0 (12.1)
0.045 inch			
10.4	48.8 (59.9)	44.8 (52.3)	17.9 (43.5)
18.4	29.9 (38.2)	32.5 (37.1)	22.0 (28.7)
95.5	25.2 (29.7)	20.3 (22.9)	13.3 (16.7)
0.060 inch			
10.4	61.3 (80.0)	58.4 (67.7)	19.4 (58.3)
18.4	39.6 (51.2)	40.3 (44.4)	17.9 (36.8)
95.5	32.9 (38.3)	23.6 (27.2)	17.0 (23.2)
		NORMAL FORCE[3,4]	
0.015 inch			
10.4	6.1 (4.6 to 7.6)	2.1 (1.6 to 2.5)	-0.1 (-0.8 to 0.4)
18.4	4.0 (3.2 to 4.7)	1.5 (1.1 to 1.8)	.0 (-.3 to .4)
95.5	2.6 (2.0 to 3.0)	1.0 (.5 to 1.8)	.0 (-.5 to .5)
0.030 inch			
10.4	9.3 (7.7 to 10.9)	3.3 (2.3 to 4.2)	-1.1 (-2.5 to .3)
18.4	6.1 (4.5 to 6.9)	2.0 (1.5 to 2.6)	-.8 (-1.4 to .2)
95.5	3.9 (2.9 to 5.0)	1.0 (.4 to 1.8)	-.7 (-1.1 to .0)
0.045 inch			
10.4	12.1 (8.5 to 15.7)	3.8 (2.6 to 5.1)	-1.2 (-3.3 to .6)
18.4	8.1 (5.5 to 9.8)	2.5 (1.8 to 3.1)	-1.3 (-2.4 to -.1)
95.5	5.4 (4.0 to 6.5)	1.0 (.4 to 2.0)	-1.0 (-1.8 to -.1)
0.060 inch			
10.4	14.6 (10.5 to 19.5)	4.6 (2.1 to 6.5)	-1.0 (-4.6 to 1.1)
18.4	9.8 (6.7 to 12.5)	3.1 (2.3 to 3.8)	-1.3 (-3.4 to .3)
95.5	6.0 (5.1 to 7.2)	1.0 (.3 to 1.9)	-1.4 (-2.8 to -.2)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 17C.--TOOL FORCES WHEN ORTHOGONALLY CUTTING WATER OAK ACROSS THE GRAIN IN THE 90-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	20	30	40
	Pounds per 0.1 inch of knife		
		PARALLEL FORCE[2]	
0.015 inch			
10.7	18.8 (24.3)	19.8 (25.7)	16.6 (23.0)
18.0	15.2 (18.9)	14.2 (18.0)	10.9 (13.6)
105.3	13.1 (16.2)	9.9 (12.0)	8.2 (10.4)
0.030 inch			
10.7	35.0 (42.6)	30.8 (39.2)	25.1 (32.9)
18.0	29.0 (35.5)	22.0 (27.7)	17.4 (21.5)
105.3	21.6 (26.3)	16.7 (20.7)	13.4 (17.1)
0.045 inch			
10.7	38.8 (50.4)	39.0 (52.3)	32.3 (40.1)
18.0	35.8 (43.8)	28.7 (35.0)	21.4 (28.1)
105.3	28.8 (33.5)	20.5 (25.6)	16.9 (21.2)
0.060 inch			
10.7	47.9 (59.8)	45.0 (58.0)	39.4 (50.6)
18.0	39.5 (48.9)	36.2 (46.6)	29.1 (37.9)
105.3	35.4 (41.8)	26.0 (31.1)	20.8 (26.1)
		NORMAL FORCE[3,4]	
0.015 inch			
10.7	2.5 (0.4 to 4.3)	-0.4 (-1.9 to 2.2)	-2.8 (-5.0 to -0.6)
18.0	1.6 (.8 to 2.7)	-.5 (-1.6 to 1.0)	-1.7 (-2.4 to -.8)
105.3	.7 (-.2 to 1.6)	-.3 (-.9 to .2)	-1.7 (-2.4 to -.7)
0.030 inch			
10.7	3.4 (.4 to 6.2)	-1.8 (-3.8 to 1.7)	-5.0 (-7.6 to -2.3)
18.0	1.7 (.2 to 3.7)	-1.7 (-3.2 to .2)	-3.7 (-5.4 to -2.3)
105.3	.8 (-.4 to 1.8)	-1.5 (-2.7 to -.3)	-3.5 (-4.9 to -1.9)
0.045 inch			
10.7	3.9 (.5 to 7.4)	-2.7 (-5.5 to .6)	-7.0 (-9.9 to -3.8)
18.0	2.2 (.1 to 4.8)	-2.7 (-5.2 to -.6)	-5.4 (-8.1 to -2.9)
105.3	.8 (-.7 to 2.4)	-2.3 (-4.1 to -.8)	-4.8 (-6.6 to -2.6)
0.060 inch			
10.7	4.2 (.0 to 8.8)	-3.0 (-6.7 to 1.1)	-9.9 (-13.4 to -4.5)
18.0	3.3 (.7 to 6.8)	-3.9 (-6.9 to -.8)	-7.8 (-11.5 to -3.0)
105.3	1.0 (-1.5 to 2.9)	-3.2 (-5.2 to -1.0)	-6.4 (-9.0 to -3.4)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 18A.--TOOL FORCES WHEN ORTHOGONALLY CUTTING WHITE OAK VENEER IN THE 0-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	50	60	70
	--------------Pounds per 0.1 inch of knife--------------		
	PARALLEL FORCE[2]		
0.015 inch			
11.5	4.0 (8.9)	4.1 (9.0)	4.0 (7.4)
19.3	3.2 (7.4)	2.9 (5.5)	5.5 (12.4)
82.1	2.0 (5.0)	2.0 (4.5)	5.3 (9.6)
0.030 inch			
11.5	5.4 (13.4)	5.1 (12.3)	4.3 (10.4)
19.3	4.5 (10.2)	4.3 (8.9)	3.7 (6.5)
82.1	3.4 (7.0)	2.9 (6.1)	2.8 (4.9)
0.045 inch			
11.5	6.6 (17.6)	6.4 (15.0)	5.7 (12.5)
19.3	5.5 (13.3)	5.3 (11.0)	5.2 (9.8)
82.1	3.9 (9.8)	3.4 (8.2)	3.3 (6.1)
0.060 inch			
11.5	7.7 (20.5)	7.1 (18.4)	6.6 (15.6)
19.3	6.5 (14.5)	6.4 (13.2)	6.4 (12.0)
82.1	4.1 (9.9)	4.4 (8.3)	4.1 (8.5)
	NORMAL FORCE[3,4]		
0.015 inch			
11.5	0.2 (-1.0 to 2.1)	0.4 (-0.9 to 1.8)	-0.3 (-2.3 to 2.6)
19.3	-.1 (-1.2 to 2.0)	-.3 (-1.5 to 1.2)	-.5 (-2.9 to 1.4)
82.1	.1 (-.6 to 1.2)	-.2 (-1.2 to .7)	-.9 (-3.2 to 1.4)
0.030 inch			
11.5	.1 (-2.1 to 2.9)	-.1 (-1.5 to 1.9)	1.3 (-1.0 to 3.2)
19.3	-.3 (-2.5 to 2.9)	-1.2 (-3.0 to .8)	.3 (-1.0 to 1.4)
82.1	-.2 (-1.2 to 1.4)	-.6 (-1.9 to .9)	.2 (-.5 to 1.4)
0.045 inch			
11.5	-.4 (-3.2 to 3.3)	-.1 (-2.3 to 2.2)	.5 (-1.6 to 3.2)
19.3	-.5 (-2.3 to 2.3)	-1.3 (-4.2 to .6)	-1.0 (-2.9 to 1.0)
82.1	-.2 (-1.6 to 1.6)	-.8 (-2.7 to .7)	-.2 (-1.5 to 1.2)
0.060 inch			
11.5	-.0 (-2.8 to 4.2)	.0 (-2.7 to 3.0)	-.2 (-3.3 to 3.3)
19.3	-.6 (-3.0 to 2.4)	-1.5 (-4.3 to 1.3)	-1.5 (-3.7 to 1.7)
82.1	-.5 (-2.0 to 1.1)	-1.0 (-2.9 to .7)	.1 (-1.8 to 2.0)

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[1] Clearance angle 0°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 18B.--TOOL FORCES WHEN ORTHOGONALLY CUTTING WHITE OAK PARALLEL TO THE GRAIN IN THE 90-0 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	10	20	30
	Pounds per 0.1 inch of knife		
		PARALLEL FORCE[2]	
0.015 inch			
10.9	19.3 (22.7)	16.2 (19.2)	5.4 (9.3)
19.6	12.0 (14.0)	8.5 (10.1)	6.4 (7.6)
75.1	9.4 (11.2)	6.5 (8.9)	4.5 (5.8)
0.030 inch			
10.9	33.3 (42.7)	31.2 (34.6)	10.4 (15.9)
19.6	21.1 (27.7)	18.6 (21.1)	11.2 (12.8)
75.1	16.4 (21.1)	10.5 (12.7)	7.4 (9.6)
0.045 inch			
10.9	41.0 (52.1)	40.8 (45.1)	12.0 (23.5)
19.6	28.0 (36.5)	24.4 (28.0)	15.5 (21.0)
75.1	24.4 (30.2)	14.9 (16.8)	9.5 (11.5)
0.060 inch			
10.9	50.2 (70.3)	54.8 (61.9)	12.7 (22.2)
19.6	35.9 (49.8)	28.2 (32.3)	18.7 (25.7)
75.1	30.8 (38.4)	18.1 (22.3)	11.4 (13.7)
		NORMAL FORCE[3,4]	
0.015 inch			
10.9	5.2 (3.4 to 6.3)	1.9 (1.3 to 2.6)	-0.4 (-0.7 to 0.2)
19.6	3.8 (2.6 to 4.3)	1.3 (.8 to 1.7)	-.1 (-.3 to .3)
75.1	2.8 (1.8 to 3.5)	1.1 (.5 to 1.9)	.2 (-.2 to .8)
0.030 inch			
10.9	8.5 (5.7 to 10.8)	3.0 (2.3 to 4.2)	-1.0 (-1.8 to -.3)
19.6	5.9 (3.9 to 7.6)	2.0 (1.5 to 2.4)	-.6 (-1.0 to -.1)
75.1	4.2 (3.0 to 5.3)	1.3 (.6 to 1.9)	-.1 (-.6 to .6)
0.045 inch			
10.9	9.5 (5.5 to 13.7)	3.9 (2.9 to 4.8)	-1.2 (-2.0 to -.4)
19.6	7.2 (4.5 to 8.9)	2.4 (1.7 to 3.2)	-1.0 (-1.3 to -.6)
75.1	6.1 (4.4 to 7.3)	1.5 (.6 to 2.0)	-.3 (-1.1 to .2)
0.060 inch			
10.9	11.6 (7.0 to 16.2)	5.3 (4.2 to 6.4)	-1.3 (-2.4 to -.5)
19.6	9.1 (6.1 to 11.8)	2.9 (2.3 to 3.6)	-1.5 (-2.4 to -.6)
75.1	7.5 (4.1 to 9.6)	1.8 (.7 to 2.8)	-.5 (-1.1 to .2)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 18C.--TOOL FORCES WHEN ORTHOGONALLY CUTTING WHITE OAK ACROSS THE GRAIN IN THE 90-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	20	30	40
	Pounds per 0.1 inch of knife		
		PARALLEL FORCE[2]	
0.015 inch			
11.2	24.6 (32.1)	20.9 (26.9)	16.1 (20.9)
18.8	16.2 (20.3)	14.1 (17.7)	10.0 (14.0)
86.3	13.9 (16.5)	11.6 (13.8)	8.8 (11.1)
0.030 inch			
11.2	39.6 (50.9)	31.6 (43.8)	26.7 (34.0)
18.8	29.9 (37.7)	21.4 (27.8)	17.2 (21.8)
86.3	23.4 (27.3)	17.4 (20.8)	13.2 (16.5)
0.045 inch			
11.2	48.7 (57.7)	43.1 (53.2)	34.3 (44.8)
18.8	34.5 (43.9)	31.0 (37.7)	20.7 (27.5)
86.3	32.8 (38.1)	23.3 (27.9)	16.9 (20.8)
0.060 inch			
11.2	54.6 (69.5)	48.0 (61.2)	41.1 (51.1)
18.8	42.3 (54.1)	36.3 (47.6)	26.8 (35.1)
86.3	38.6 (47.6)	28.0 (33.1)	21.0 (26.5)
		NORMAL FORCE[3,4]	
0.015 inch			
11.2	1.3 (-0.2 to 3.7)	-1.7 (-3.0 to 0.1)	-3.7 (-5.3 to -1.6)
18.8	1.0 (.3 to 1.8)	-.7 (-1.8 to .4)	-2.1 (-3.4 to -1.1)
86.3	.5 (.0 to 1.1)	-.8 (-1.6 to -.1)	-1.9 (-2.5 to -.9)
0.030 inch			
11.2	.9 (-1.3 to 4.6)	-3.6 (-6.2 to .7)	-7.2 (-10.0 to -4.4)
18.8	1.1 (-.3 to 3.2)	-2.3 (-4.1 to -.7)	-4.6 (-6.4 to -2.4)
86.3	.4 (-.6 to 1.3)	-1.9 (-3.2 to -.7)	-3.7 (-5.0 to -1.9)
0.045 inch			
11.2	1.0 (-2.4 to 3.8)	-5.5 (-8.5 to -1.2)	-9.9 (-13.4 to -4.7)
18.8	1.1 (-.8 to 4.2)	-3.7 (-6.4 to -.8)	-6.0 (-9.0 to -3.2)
86.3	.4 (-1.0 to 1.6)	-3.2 (-4.9 to -1.4)	-5.6 (-7.2 to -3.1)
0.060 inch			
11.2	1.0 (-2.7 to 6.2)	-6.3 (-10.8 to -.5)	-12.2 (-17.4 to -5.7)
18.8	.9 (-1.0 to 4.5)	-4.1 (-7.5 to -.1)	-8.1 (-12.3 to -3.7)
86.3	.6 (-1.4 to 2.7)	-4.1 (-6.3 to -2.2)	-6.8 (-9.0 to -3.3)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 19A.--TOOL FORCES WHEN ORTHOGONALLY CUTTING SWEETBAY VENEER IN THE 0-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	50	60	70
	Pounds per 0.1 inch of knife		
	PARALLEL FORCE[2]		
0.015 inch			
11.3	2.2 (4.3)	2.0 (3.5)	2.1 (3.2)
18.7	2.1 (4.3)	1.9 (3.1)	2.9 (5.4)
150.8	1.6 (2.8)	1.5 (2.0)	2.5 (3.9)
0.030 inch			
11.3	3.3 (7.0)	2.7 (5.2)	2.5 (4.0)
18.7	2.8 (5.4)	2.5 (4.0)	2.3 (3.7)
150.8	2.1 (3.8)	1.9 (2.9)	1.7 (2.5)
0.045 inch			
11.3	3.8 (8.3)	3.3 (6.4)	3.0 (6.0)
18.7	2.9 (5.5)	3.0 (5.2)	2.9 (4.7)
150.8	2.2 (4.7)	2.3 (3.6)	2.0 (3.0)
0.060 inch			
11.3	4.0 (9.4)	3.5 (7.5)	3.4 (6.7)
18.7	3.5 (6.5)	3.4 (6.2)	3.0 (4.8)
150.8	2.6 (5.4)	2.5 (4.2)	2.3 (3.3)
	NORMAL FORCE[3,4]		
0.015 inch			
11.3	0.1 (-0.4 to 1.1)	-0.1 (-0.5 to .5)	-0.1 (-0.7 to 0.6)
18.7	.6 (-.2 to 2.0)	-.2 (-.6 to .5)	-.4 (-1.4 to .6)
150.8	.2 (-.2 to 1.1)	.0 (-.3 to .4)	-.5 (-1.3 to .5)
0.030 inch			
11.3	-.1 (-.8 to 1.2)	-.5 (-1.3 to .2)	.2 (-.4 to 1.1)
18.7	-.3 (-.9 to .8)	-.5 (-1.2 to .2)	.1 (-.5 to .9)
150.8	-.1 (-.7 to .7)	-.3 (-.8 to .3)	.2 (-.3 to .5)
0.045 inch			
11.3	-.2 (-1.2 to 1.0)	-.8 (-1.9 to .1)	-.2 (-1.2 to .6)
18.7	-.4 (-1.1 to .6)	-.9 (-1.8 to .1)	-.4 (-1.2 to .9)
150.8	-.2 (-.8 to .5)	-.6 (-1.2 to .1)	-.4 (-.8 to .1)
0.060 inch			
11.3	-.2 (-1.5 to 1.0)	-.6 (-2.0 to .6)	-.2 (-1.5 to 1.1)
18.7	-.4 (-1.5 to .6)	-1.0 (-2.2 to .2)	-1.0 (-1.9 to .1)
150.8	-.4 (-1.2 to .5)	-.7 (-1.7 to .0)	-.7 (-1.4 to -.1)

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[1] Clearance angle 0°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 19B.--TOOL FORCES WHEN ORTHOGONALLY CUTTING SWEETBAY PARALLEL TO THE GRAIN IN THE 90-0 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	10	20	30
	--------------Pounds per 0.1 inch of knife--------------		
		PARALLEL FORCE[2]	
0.015 inch			
10.7	12.1 (15.6)	12.3 (13.2)	8.6 (11.3)
19.2	9.9 (11.9)	8.4 (9.6)	6.9 (7.8)
102.7	6.3 (8.5)	4.0 (5.7)	3.4 (4.5)
0.030 inch			
10.7	20.6 (27.7)	23.4 (25.8)	12.2 (22.1)
19.2	18.3 (24.4)	16.0 (17.8)	13.0 (15.7)
102.7	12.6 (15.9)	8.8 (11.5)	5.2 (7.3)
0.045 inch			
10.7	31.7 (41.1)	36.0 (39.5)	11.0 (29.5)
19.2	25.4 (32.7)	23.9 (25.6)	16.1 (21.3)
102.7	16.3 (23.0)	12.6 (17.0)	7.0 (10.3)
0.060 inch			
10.7	40.8 (50.9)	43.4 (48.2)	10.5 (34.8)
19.2	31.3 (43.7)	30.7 (33.5)	19.9 (26.1)
102.7	20.6 (27.9)	17.7 (22.3)	8.1 (11.7)
		NORMAL FORCE[3,4]	
0.015 inch			
10.7	3.6 (2.2 to 4.9)	1.7 (1.4 to 1.9)	-0.3 (-0.6 to 0.1)
19.2	3.4 (2.2 to 4.3)	1.4 (1.0 to 1.7)	.3 (-.1 to .6)
102.7	2.7 (1.3 to 4.8)	1.1 (.5 to 2.1)	.4 (-.1 to 1.2)
0.030 inch			
10.7	5.7 (3.1 to 7.6)	2.8 (2.5 to 3.2)	-.8 (-1.5 to .1)
19.2	5.6 (3.2 to 8.0)	2.1 (1.7 to 2.6)	-.4 (-.9 to .1)
102.7	3.3 (2.0 to 5.0)	.9 (.5 to 1.7)	.1 (-.4 to .7)
0.045 inch			
10.7	8.2 (5.0 to 11.1)	3.7 (2.7 to 4.5)	-.7 (-2.0 to .2)
19.2	6.7 (3.8 to 10.8)	2.7 (2.3 to 3.1)	-.9 (-1.5 to -.3)
102.7	4.3 (2.2 to 6.0)	1.1 (.5 to 1.8)	-.3 (-1.0 to .2)
0.060 inch			
10.7	10.3 (4.9 to 13.4)	5.1 (4.6 to 5.7)	-.6 (-2.6 to .3)
19.2	8.0 (5.0 to 12.2)	3.4 (2.6 to 3.8)	-1.1 (-1.9 to .0)
102.7	5.6 (3.0 to 8.6)	1.1 (.5 to 1.8)	-.5 (-1.1 to .3)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 19C.--TOOL FORCES WHEN ORTHOGONALLY CUTTING SWEETBAY ACROSS THE GRAIN IN THE 90-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	20	30	40
	Pounds per 0.1 inch of knife		
		PARALLEL FORCE[2]	
0.015 inch			
11.0	16.9 (22.1)	14.5 (19.6)	11.1 (15.1)
17.6	14.5 (17.4)	11.8 (15.4)	9.4 (11.4)
146.5	9.8 (11.6)	9.5 (11.0)	6.8 (8.2)
0.030 inch			
11.0	26.1 (33.1)	22.7 (30.9)	18.6 (22.0)
17.6	25.3 (29.4)	19.0 (22.8)	14.7 (18.0)
146.5	19.0 (21.4)	15.7 (19.3)	10.1 (12.4)
0.045 inch			
11.0	28.6 (37.4)	27.4 (37.0)	24.5 (31.2)
17.6	29.4 (36.0)	25.7 (30.2)	19.0 (23.2)
146.5	24.6 (28.5)	19.1 (23.9)	13.2 (15.9)
0.060 inch			
11.0	33.6 (49.0)	29.5 (38.5)	27.6 (40.4)
17.6	31.5 (40.0)	30.6 (37.1)	22.7 (28.9)
146.5	29.2 (35.8)	22.8 (28.3)	17.4 (22.7)
		NORMAL FORCE[3,4]	
0.015 inch			
11.0	3.2 (1.4 to 6.9)	1.7 (0.0 to 4.3)	-0.2 (-2.2 to 1.9)
17.6	1.8 (1.1 to 3.5)	.4 (-.4 to 1.4)	-.8 (-1.3 to .1)
146.5	.8 (.6 to 1.3)	.1 (-.4 to 6)	-.7 (-1.2 to -.1)
0.030 inch			
11.0	5.1 (2.1 to 9.4)	2.0 (-1.0 to 6.9)	-2.2 (-3.4 to .9)
17.6	2.8 (1.3 to 4.9)	-.2 (-1.5 to 1.2)	-2.1 (-3.5 to -.6)
146.5	1.1 (.5 to 1.8)	-.8 (-2.0 to .2)	-1.8 (-2.8 to -1.0)
0.045 inch			
11.0	7.2 (2.6 to 13.9)	2.8 (-1.3 to 7.9)	-2.4 (-5.6 to 3.9)
17.6	3.3 (.5 to 5.5)	-1.2 (-3.1 to 1.2)	-3.3 (-5.2 to -.6)
146.5	1.2 (.1 to 2.3)	-1.6 (-3.0 to .0)	-2.9 (-4.5 to -1.2)
0.060 inch			
11.0	7.3 (1.6 to 17.9)	4.5 (-2.1 to 12.2)	-1.9 (-7.5 to 4.8)
17.6	3.0 (.4 to 6.1)	-1.6 (-4.3 to 1.7)	-4.6 (-7.2 to -.8)
146.5	1.3 (-.8 to 3.6)	-2.3 (-4.3 to -.2)	-4.7 (-6.7 to -2.1)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 20A.--TOOL FORCES WHEN ORTHOGONALLY CUTTING SWEETGUM VENEER IN THE 0-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	50	60	70
	Pounds per 0.1 inch of knife		
		PARALLEL FORCE[2]	
0.015 inch			
11.4	2.2 (3.5)	2.4 (3.3)	3.8 (7.2)
20.4	2.0 (2.8)	1.7 (2.0)	2.9 (4.9)
157.0	1.6 (2.0)	1.3 (1.6)	2.9 (4.1)
0.030 inch			
11.4	3.3 (5.8)	3.3 (5.1)	2.5 (3.6)
20.4	3.0 (4.6)	2.3 (3.4)	2.1 (2.6)
157.0	2.0 (3.2)	1.9 (2.4)	1.7 (2.0)
0.045 inch			
11.4	3.6 (7.5)	3.6 (6.7)	2.8 (4.9)
20.4	3.4 (5.5)	3.1 (4.3)	2.7 (3.6)
157.0	2.6 (4.3)	2.1 (3.0)	2.1 (2.6)
0.060 inch			
11.4	4.0 (9.6)	3.6 (8.0)	3.2 (6.2)
20.4	3.8 (6.8)	3.3 (5.5)	3.3 (4.4)
157.0	3.0 (5.0)	2.5 (4.3)	2.4 (3.5)
		NORMAL FORCE[3,4]	
0.015 inch			
11.4	0.0 (-0.3 to 0.5)	-0.2 (-0.5 to 0.2)	-1.2 (-2.5 to 0.1)
20.4	-.1 (-.4 to .3)	-.4 (-.7 to -.1)	-.5 (-1.6 to .6)
157.0	.1 (-.1 to .3)	.0 (-.3 to .3)	-.5 (-1.3 to .3)
0.030 inch			
11.4	-.4 (-1.1 to .3)	-.8 (-1.4 to .0)	-.3 (-.7 to .3)
20.4	-.6 (-1.0 to -.1)	-.9 (-1.3 to -.5)	-.4 (-.6 to -.1)
157.0	-.3 (-.6 to .1)	-.4 (-.8 to .0)	.2 (-.2 to .4)
0.045 inch			
11.4	-.7 (-1.7 to .2)	-.8 (-2.1 to .2)	-.7 (-1.4 to .0)
20.4	-.8 (-1.4 to .0)	-1.3 (-1.9 to -.5)	-.9 (-1.3 to -.2)
157.0	-.4 (-1.0 to .2)	-.7 (-1.2 to -.1)	-.3 (-.7 to .2)
0.060 inch			
11.4	-.7 (-2.0 to .4)	-.9 (-2.4 to .3)	-.8 (-1.9 to .3)
20.4	-1.0 (-1.9 to .1)	-1.5 (-2.4 to -.2)	-1.3 (-2.0 to .1)
157.0	-.6 (-1.3 to .2)	-.9 (-1.6 to .0)	-.8 (-1.2 to .1)

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[1] Clearance angle 0°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 20B.--TOOL FORCES WHEN ORTHOGONALLY CUTTING SWEETGUM PARALLEL TO THE GRAIN IN THE 90-0 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	10	20	30
	Pounds per 0.1 inch of knife		
		PARALLEL FORCE[2]	
0.015 inch			
10.9	13.5 (18.2)	12.6 (13.9)	9.2 (11.8)
20.0	8.3 (9.7)	7.4 (7.9)	6.1 (6.9)
130.0	5.8 (7.3)	4.9 (6.0)	3.5 (4.2)
0.030 inch			
10.9	27.7 (36.2)	24.2 (26.8)	14.1 (23.3)
20.0	15.3 (19.6)	14.1 (15.7)	11.2 (13.2)
130.0	10.7 (14.0)	8.7 (10.6)	6.4 (8.0)
0.045 inch			
10.9	33.7 (45.6)	32.6 (36.7)	12.7 (34.4)
20.0	21.4 (28.6)	20.8 (22.8)	15.2 (19.0)
130.0	14.8 (20.3)	12.2 (15.4)	8.0 (10.7)
0.060 inch			
10.9	43.2 (56.8)	42.0 (49.9)	11.3 (40.5)
20.0	28.2 (37.3)	27.4 (31.5)	16.3 (24.9)
130.0	17.7 (25.5)	16.5 (19.6)	9.1 (12.4)
		NORMAL FORCE[3,4]	
0.015 inch			
10.9	4.3 (2.2 to 6.2)	2.1 (1.7 to 2.4)	-0.2 (-0.6 to 0.2)
20.0	2.6 (1.8 to 3.3)	1.1 (.9 to 1.5)	.2 (-.1 to .3)
130.0	2.2 (1.2 to 2.7)	.9 (.8 to 1.1)	.5 (.2 to .8)
0.030 inch			
10.9	7.7 (4.6 to 10.7)	3.3 (2.9 to 3.8)	-.7 (-1.5 to .0)
20.0	4.3 (2.8 to 5.3)	1.7 (1.4 to 2.1)	-.4 (-.7 to .0)
130.0	3.2 (1.9 to 4.4)	1.2 (.9 to 1.5)	.3 (-.2 to .6)
0.045 inch			
10.9	9.3 (5.5 to 12.5)	4.2 (3.6 to 4.8)	-.7 (-2.3 to .2)
20.0	6.0 (3.9 to 8.6)	2.3 (1.9 to 2.6)	-.7 (-1.3 to -.1)
130.0	4.0 (2.3 to 5.3)	1.3 (.9 to 1.8)	.0 (-.5 to .7)
0.060 inch			
10.9	11.6 (7.4 to 15.5)	5.1 (4.1 to 5.9)	-.9 (-2.6 to .0)
20.0	7.4 (4.3 to 10.3)	2.4 (1.9 to 2.9)	-.8 (-1.8 to .1)
130.0	4.8 (2.7 to 6.4)	1.5 (1.2 to 2.0)	.0 (-.6 to .9)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 20C.--TOOL FORCES WHEN ORTHOGONALLY CUTTING SWEETGUM ACROSS THE GRAIN IN THE 90-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	20	30	40
	Pounds per 0.1 inch of knife		
	PARALLEL FORCE[2]		
0.015 inch			
10.6	15.9 (20.3)	13.6 (16.7)	10.0 (12.1)
19.2	14.0 (16.6)	10.6 (12.6)	7.8 (9.7)
147.9	9.5 (10.8)	8.6 (10.2)	6.9 (7.9)
0.030 inch			
10.6	28.0 (33.8)	21.6 (26.0)	16.4 (21.2)
19.2	24.9 (27.9)	16.8 (18.9)	12.8 (14.8)
147.9	17.4 (20.0)	14.9 (17.6)	10.3 (12.5)
0.045inch			
10.6	36.1 (44.7)	31.8 (39.0)	20.7 (26.8)
19.2	32.9 (37.0)	23.2 (26.7)	17.1 (21.5)
147.9	24.2 (27.8)	18.3 (22.3)	13.0 (16.9)
0.060 inch			
10.6	40.7 (53.8)	36.3 (45.4)	27.5 (37.8)
19.2	36.1 (42.7)	28.7 (33.6)	21.0 (28.5)
147.9	30.0 (53.9)	22.4 (27.1)	15.3 (20.5)
	NORMAL FORCE[3,4]		
0.015 inch			
10.6	1.8 (0.7 to 2.8)	0.5 (-0.2 to 1.8)	-1.3 (-2.0 to -0.4)
19.2	1.8 (1.1 to 2.6)	.2 (-.5 to .6)	-1.0 (-1.4 to -.4)
147.9	.9 (.6 to 1.3)	.0 (-.4 to .4)	-.7 (-1.0 to -.1)
0.030 inch			
10.6	4.0 (1.7 to 6.0)	.2 (-1.0 to 1.7)	-3.1 (-4.4 to -1.6)
19.2	2.2 (1.2 to 3.5)	-.7 (-1.8 to .4)	-2.4 (-3.2 to -1.4)
147.9	.9 (.6 to 1.6)	-.8 (-1.8 to .0)	-2.0 (-2.9 to -1.0)
0.045 inch			
10.6	5.6 (2.5 to 9.3)	-.5 (-2.7 to 2.0)	-4.3 (-6.2 to -1.8)
19.2	3.1 (1.6 to 5.0)	-1.7 (-3.2 to -.2)	-3.7 (-5.3 to -1.7)
147.9	.8 (-.2 to 1.9)	-1.5 (-2.9 to -.3)	-3.3 (-4.9 to -1.4)
0.060 inch			
10.6	5.2 (1.6 to 9.4)	-.1 (-2.5 to 3.4)	-5.7 (-8.9 to -1.8)
19.2	2.6 (.2 to 4.8)	-2.6 (-4.7 to -.6)	-5.2 (-7.6 to -1.7)
147.9	.6 (-1.2 to 2.2)	-2.3 (-4.5 to -.5)	-4.7 (-7.0 to -.8)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five)

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 21A.--TOOL FORCES WHEN ORTHOGONALLY CUTTING BLACK TUPELO VENEER IN THE 0-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	50	60	70
	Pounds per 0.1 inch of knife		
		PARALLEL FORCE[2]	
0.015 inch			
11.4	3.1 (5.4)	2.8 (4.2)	3.7 (5.7)
19.5	2.7 (3.8)	2.3 (3.4)	3.8 (7.5)
124.7	1.8 (2.5)	1.5 (2.1)	3.7 (5.4)
0.030 inch			
11.4	4.5 (7.8)	3.9 (6.6)	3.3 (4.9)
19.5	3.8 (5.5)	3.4 (4.8)	2.8 (3.7)
124.7	2.7 (3.9)	2.2 (3.0)	2.0 (2.4)
0.045 inch			
11.4	5.1 (10.3)	4.6 (9.2)	4.4 (7.0)
19.5	4.8 (7.5)	4.1 (6.3)	3.3 (4.7)
124.7	3.0 (5.2)	2.8 (4.2)	2.6 (3.4)
0.060 inch			
11.4	5.7 (12.4)	5.4 (10.4)	5.2 (10.0)
19.5	5.3 (8.8)	4.8 (7.5)	4.1 (6.0)
124.7	3.5 (6.4)	3.1 (5.2)	3.0 (4.1)
		NORMAL FORCE[3,4]	
0.015 inch			
11.4	-0.4 (-1.0 to 0.3)	-0.5 (-0.9 to .0)	-0.5 (-1.6 to 0.7)
19.5	-.3 (-.7 to .0)	-.7 (-1.0 to .0)	-.8 (-2.6 to .5)
124.7	-.1 (-.3 to .2)	-.3 (-.6 to .1)	-1.3 (-2.4 to -.1)
0.030 inch			
11.4	-.9 (-1.9 to .2)	-1.1 (-2.2 to -.1)	-.6 (-1.5 to .3)
19.5	-1.0 (-1.6 to -.1)	-1.4 (-2.1 to -.6)	-.8 (-1.2 to -.1)
124.7	-.5 (-.9 to .1)	-.8 (-1.3 to -.3)	-.1 (-.5 to .4)
0.045 inch			
11.4	-1.1 (-2.3 to .0)	-1.2 (-2.6 to 1)	-1.1 (-2.3 to .0)
19.5	-1.1 (-2.3 to -.2)	-1.8 (-2.7 to -.5)	-1.5 (-2.2 to -.5)
124.7	-.7 (-1.3 to .2)	-1.1 (-1.8 to -.3)	-.9 (-1.3 to -.3)
0.060 inch			
11.4	-1.2 (-3.0 to .3)	-1.3 (-2.9 to .3)	-1.2 (-2.9 to .7)
19.5	-1.5 (-2.8 to -.2)	-2.0 (-3.3 to -.5)	-2.0 (-3.0 to -.7)
124.7	-.8 (-1.7 to .2)	-1.5 (-2.5 to -.3)	-1.3 (-2.0 to -.3)

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[1] Clearance angle 0°; cutting velocity 5 inches per minute

[2] The first number in each entry is the average cutting force; the numbers following in parentehses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five)

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 21B.--TOOL FORCES WHEN ORTHOGONALLY CUTTING BLACK TUPELO PARALLEL TO THE GRAIN IN THE 90-0 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	10	20	30
	Pounds per 0.1 inch of knife		
	PARALLEL FORCE[2]		
0.015 inch			
10.9	15.0 (20.2)	11.6 (13.4)	9.0 (12.3)
19.1	9.9 (14.8)	7.5 (9.0)	7.5 (8.9)
113.0	7.3 (9.6)	5.5 (6.5)	4.1 (4.6)
0.030 inch			
10.9	26.8 (35.3)	26.7 (30.6)	14.7 (23.1)
19.1	17.8 (24.8)	15.6 (18.4)	12.7 (14.7)
113.0	14.0 (18.9)	9.1 (10.7)	6.8 (8.0)
0.045 inch			
10.9	35.3 (47.7)	37.1 (41.4)	14.7 (31.2)
19.1	25.8 (34.4)	21.2 (24.2)	14.7 (18.8)
113.0	17.2 (25.2)	11.2 (14.3)	9.3 (11 6)
0.060 inch			
10.9	43.3 (58.7)	48.5 (52.8)	15.6 (40.7)
19.1	34.8 (43.8)	28.3 (31.0)	18.0 (22.9)
113.0	21.2 (27.4)	14.8 (19.9)	13.3 (16.3)
	NORMAL FORCE[3,4]		
0.015 inch			
10.9	4.9 (2.9 to 7.0)	1.7 (1.4 to 2.2)	-0.1 (-0.5 to 0.3)
19.1	4.2 (1.8 to 6.5)	1.3 (.9 to 2.1)	.1 (-.3 to .5)
113.0	3.0 (1.5 to 5.2)	1.2 (.8 to 1.4)	.5 (.2 to .7)
0.030 inch			
10.9	7.8 (4.1 to 10.3)	3.3 (2.8 to 3.8)	-.5 (-1.4 to .2)
19.1	6.4 (2.8 to 10.1)	2.0 (1.4 to 2.7)	-.3 (-.8 to .1)
113.0	4.7 (2.3 to 6.5)	1.2 (.7 to 1.6)	.2 (-.1 to .4)
0.045 inch			
10.9	9.9 (6.0 to 13.0)	4.4 (3.7 to 5.0)	-.7 (-2.3 to .5)
19.1	8.0 (4.4 to 11.4)	2.4 (2.0 to 3.2)	-.4 (-1.1 to .2)
113.0	5.4 (2.7 to 8.0)	1.2 (.7 to 1.6)	.0 (-.3 to .4)
0.060 inch			
10.9	11.3 (7.2 to 15.5)	5.7 (5.1 to 6.1)	-1.0 (-3.0 to .3)
19.1	9.9 (5.2 to 13.0)	3.2 (2.5 to 3.9)	-.9 (-1.7 to -.1)
113.0	6.3 (3.3 to 8.9)	1.2 (.5 to 2.2)	-.6 (-1.0 to -.1)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 21C.--TOOL FORCES WHEN ORTHOGONALLY CUTTING BLACK TUPELO ACROSS THE GRAIN IN THE 90-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	20	30	40
	Pounds per 0.1 inch of knife		
	PARALLEL FORCE[2]		
0.015 inch			
10.4	20.1 (27.8)	17.0 (20.7)	10.9 (13.7)
19.0	15.6 (17.7)	12.2 (14.2)	9.9 (11.6)
125.2	11.5 (13.5)	9.5 (11.0)	7.5 (8.7)
0.030 inch			
10.4	34.4 (44.6)	27.4 (34.4)	20.5 (25.5)
19.0	30.0 (35.1)	20.5 (24.3)	15.3 (18.2)
125.2	19.8 (22.7)	15.0 (18.3)	10.9 (12.4)
0.045 inch			
10.4	45.9 (61.4)	37.3 (45.2)	28.3 (34.4)
19.0	37.8 (45.2)	25.6 (30.3)	20.1 (24.2)
125.2	28.1 (32.3)	19.5 (23.4)	14.1 (17.0)
0.060 inch			
10.4	59.5 (71.8)	46.0 (56.7)	35.9 (45.0)
19.0	45.9 (56.6)	34.4 (41.9)	25.0 (31.4)
125.2	34.2 (39.5)	24.7 (31.5)	17.5 (22.2)
	NORMAL FORCE[3,4]		
0.015 inch			
10.4	2.6 (0.8 to 7.8)	0.4 (-0.6 to 2.9)	-1.5 (-2.3 to -0.4)
19.0	1.6 (1.1 to 2.1)	-.1 (-.6 to .5)	-1.3 (-1.9 to -.7)
125.2	.8 (.6 to 1.3)	-.1 (-.5 to .6)	-1.2 (-1.8 to -.8)
0.030 inch			
10.4	3.5 (.8 to 7.2)	-.7 (-2.6 to 3.3)	-4.6 (-6.2 to -1.4)
19.0	2.1 (1.3 to 3.7)	-1.3 (-2.2 to -.2)	-3.2 (-4.3 to -2.2)
125.2	.9 (.4 to 1.8)	-1.0 (-2.1 to .1)	-2.6 (-3.4 to -1.7)
0.045 inch			
10.4	4.6 (1.3 to 9.1)	-1.5 (-4.6 to 3.9)	-6.1 (-8.7 to -1.6)
19.0	2.3 (1.2 to 4.0)	-2.4 (-4.4 to -.5)	-4.8 (-6.7 to -2.9)
125.2	.8 (-.4 to 1.7)	-2.3 (-3.4 to -.7)	-3.9 (-5.6 to -2.6)
0.060 inch			
10.4	4.9 (-.2 to 12.3)	-3.1 (-6.3 to 5.4)	-8.4 (-12.7 to -3.5)
19.0	1.7 (.1 to 4.7)	-3.6 (-6.4 to -.7)	-6.9 (-9.7 to -3.3)
125.2	.6 (-.5 to 2.6)	-3.2 (-5.9 to -1.5)	-5.0 (-7.1 to -2.7)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 22A.--TOOL FORCES WHEN ORTHOGONALLY CUTTING YELLOW-POPLAR VENEER IN THE 0-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	50	60	70
	Pounds per 0.1 inch of knife		
	PARALLEL FORCE[2]		
0.015 inch			
10.6	1.7 (3.5)	1.6 (2.8)	3.4 (5.4)
18.8	1.6 (3.4)	1.4 (2.5)	2.4 (5.0)
180.9	1.6 (2.3)	1.2 (1.8)	2.2 (3.7)
0.030 inch			
10.6	2.2 (4.7)	1.9 (3.9)	1.9 (3.3)
18.8	2.1 (4.0)	2.0 (3.5)	2.0 (3.0)
180.9	1.8 (3.1)	1.7 (2.3)	1.5 (2.2)
0.045 inch			
10.6	2.6 (6.1)	2.2 (4.9)	2.3 (4.4)
18.8	2.7 (5.4)	2.3 (4.2)	2.1 (3.4)
180.9	2.1 (3.7)	1.7 (2.7)	1.8 (2.4)
0.060 inch			
10.6	2.7 (6.8)	2.2 (5.7)	2.4 (4.7)
18.8	3.1 (5.8)	2.9 (5.3)	2.5 (4.1)
180.9	2.2 (4.3)	2.0 (3.4)	2.1 (3.0)
	PARALLEL FORCE[3,4]		
0.015 inch			
10.6	0.2 (-0.2 to 0.8)	0.1 (-0.4 to .6)	-0.3 (-1.8 to 1.2)
18.8	.3 (-.1 to 1.1)	.3 (-.3 to 1.0)	.3 (-.6 to 1.4)
180.9	.5 (.0 to 1.0)	.3 (-.2 to .8)	.0 (-1.0 to .9)
0.030 inch			
10.6	.0 (-.6 to .5)	-.3 (-.8 to .2)	.2 (-.5 to .9)
18.8	-.1 (-.5 to .6)	-.4 (-.9 to .2)	.1 (-.4 to .7)
180.9	.1 (-.4 to .7)	-.1 (-.6 to .2)	.3 (.0 to .7)
0.045 inch			
10.6	-.1 (-.9 to .6)	-.3 (-1.0 to .3)	-.3 (-1.0 to .5)
18.8	-.3 (-1.0 to .5)	-.5 (-1.2 to .0)	-.4 (-.9 to .4)
180.9	.1 (-.5 to .7)	-.3 (-.9 to .2)	-.1 (-.5 to .3)
0.060 inch			
10.6	-.1 (-1.4 to 1.2)	-.5 (-1.6 to .4)	-.4 (-1.3 to .7)
18.8	-.4 (-1.2 to .5)	-.8 (-1.6 to .3)	-.6 (-1.2 to .1)
180.9	-.1 (-.7 to .6)	-.6 (-1.2 to .0)	-.3 (-.8 to .4)

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[1] Clearance angle 0°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 22B.--TOOL FORCES WHEN ORTHOGONALLY CUTTING YELLOW-POPLAR PARALLEL TO THE GRAIN IN THE 90-0 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	10	20	30
	Pounds per 0.1 inch of knife		
	PARALLEL FORCE[2]		
0.015 inch			
10.4	9.8 (12.9)	10.1 (12.2)	6.9 (10.3)
19.2	8.6 (10.7)	6.9 (7.8)	6.4 (7.4)
124.4	6.5 (7.9)	5.6 (7.1)	4.2 (5.4)
0.030 inch			
10.4	20.1 (25.5)	18.6 (25.2)	10.7 (19.8)
19.2	15.4 (20.2)	13.9 (15.9)	11.7 (15.0)
124.4	12.8 (16.8)	10.2 (11.8)	7.5 (9.7)
0.045 inch			
10.4	28.4 (36.4)	25.8 (35.3)	6.9 (24.6)
19.2	21.0 (26.5)	20.2 (23.1)	14.3 (21.8)
124.4	16.6 (20.4)	14.7 (17.6)	8.9 (12.0)
0.060 inch			
10.4	37.4 (45.7)	30.5 (43.3)	6.6 (30.2)
19.2	27.3 (34.2)	26.1 (30.7)	16.9 (29.2)
124.4	20.3 (26.6)	19.4 (22.7)	10.6 (17.4)
	NORMAL FORCE[3,4]		
0.015 inch			
10.4	2.6 (1.3 to 4.0)	1.4 (1.0 to 2.0)	-0.3 (-0.7 to 0.0)
19.2	3.2 (2.3 to 4.2)	1.3 (.9 to 1.6)	.4 (.0 to 1.0)
124.4	3.6 (2.3 to 4.9)	1.3 (.7 to 2.0)	1.0 (.3 to 1.7)
0.030 inch			
10.4	4.7 (2.6 to 7.0)	2.3 (1.6 to 2.9)	-.7 (-1.7 to .0)
19.2	4.8 (3.0 to 6.4)	1.8 (1.3 to 2.4)	-.1 (-.6 to .7)
124.4	5.7 (2.4 to 8.6)	1.6 (1.0 to 2.5)	.8 (-.0 to 2.1)
0.045 inch			
10.4	6.0 (2.6 to 8.8)	3.4 (2.6 to 4.2)	-.4 (-2.2 to .3)
19.2	6.6 (3.2 to 9.5)	2.2 (1.8 to 2.7)	-.3 (-1.3 to .5)
124.4	5.8 (2.6 to 8.7)	1.6 (.9 to 2.3)	.5 (-.2 to 1.4)
0.060 inch			
10.4	8.1 (3.0 to 11.7)	3.4 (2.5 to 4.1)	-.5 (-2.6 to .3)
19.2	7.7 (3.9 to 10.9)	2.9 (2.2 to 3.8)	-.4 (-1.8 to .8)
124.4	7.2 (4.0 to 8.9)	1.7 (.9 to 2.5)	.7 (-.4 to 1.6)

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[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

TABLE 22C.--TOOL FORCES WHEN ORTHOGONALLY CUTTING YELLOW-POPLAR ACROSS THE GRAIN IN THE 90-90 DIRECTION[1]

Depth of cut and moisture content (percent)	Rake angle, degrees		
	20	30	40
	Pounds per 0.1 inch of knife		
	PARALLEL FORCE[2]		
0.015 inch			
10.8	12.1 (16.7)	19.8 (23.3)	7.7 (10.8)
17.7	12.3 (14.7)	9.6 (13.4)	8.2 (10.4)
165.5	8.5 (10.2)	7.8 (9.0)	5.8 (7.0)
0.030 inch			
10.8	18.7 (26.4)	16.7 (22.9)	12.3 (15.8)
17.7	22.1 (27.4)	15.0 (20.1)	12.3 (15.1)
165.5	15.5 (18.2)	12.8 (15.2)	8.1 (9.8)
0.045 inch			
10.8	24.1 (37.2)	19.1 (24.2)	17.2 (22.5)
17.7	26.2 (32.7)	20.3 (25.0)	14.7 (19.0)
165.5	21.1 (24.3)	16.3 (19.5)	10.6 (14.0)
0.060 inch			
10.8	28.2 (46.3)	18.9 (28.8)	20.5 (25.1)
17.7	27.4 (35.6)	24.9 (29.2)	18.8 (24.3)
165.5	25.7 (29.2)	20.4 (25.4)	12.9 (16.6)
	NORMAL FORCE[3,4]		
0.015 inch			
10.8	3.3 (1.2 to 6.9)	1.2 (-0.2 to 3.0)	-0.3 (-1.5 to 1.4)
17.7	1.6 (.9 to 2.6)	.2 (-.3 to .8)	-.6 (-1.3 to .1)
165.5	.8 (.6 to 1.2)	.3 (.0 to .8)	-.5 (-.9 to .0)
0.030 inch			
10.8	4.1 (1.4 to 7.6)	1.3 (-.6 to 4.0)	-1.0 (-2.4 to .4)
17.7	2.2 (1.1 to 3.8)	-.3 (-1.1 to .6)	-1.8 (-2.8 to -.9)
165.5	1.3 (.7 to 1.7)	-.1 (-.7 to .6)	-1.1 (-2.1 to -.5)
0.045 inch			
10.8	5.1 (1.9 to 9.4)	2.0 (-.4 to 5.4)	-2.1 (-4.2 to .6)
17.7	2.7 (.8 to 4.8)	-.8 (-2.3 to .3)	-2.7 (-4.5 to -1.2)
165.5	1.4 (.5 to 2.1)	-.5 (-1.6 to .3)	-2.1 (-3.3 to -1.0)
0.060 inch			
10.8	5.0 (.4 to 10.7)	3.4 (-.7 to 10.4)	-2.8 (-5.9 to 1.1)
17.7	2.9 (.2 to 4.9)	-1.4 (-2.7 to -.1)	-3.8 (-6.0 to -1.5)
165.5	1.3 (.1 to 2.6)	-.9 (-2.1 to .3)	-3.0 (-4.9 to -1.2)

---

[1] Clearance angle 15°; cutting velocity 5 inches per minute.

[2] The first number in each entry is the average cutting force; the numbers following in parentheses are maximum forces (average of five).

[3] The first number in each entry is the average cutting force; the numbers following in parentheses are minimum and maximum forces (average of five).

[4] A negative normal force indicates that the knife tended to lift the workpiece; force was positive when the knife pushed the workpiece.

Woodson, G. E.

1979. Tool forces and chip types in orthogonal cutting of southern hardwoods. U.S. Dep. Agric. For. Serv. Res. Pap. SO-146, 77 p. South. For. Exp. Stn., New Orleans, La.

One-eighth to one-quarter inch thick specimens from each of 22 hardwood species were cut at 5 inches per minute orthogonally — as with a carpenter's plane in the three major modes, that is, planing (90-0), veneer (0-90), and crosscut (90-90) directions. Parallel and normal cutting forces for various rake angles were measured at three moisture contents and four depths of cut.

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Yields of Unthinned Slash Pine Plantations on Cutover Sites in the West Gulf Region

T. R. DELL, D. P. FEDUCCIA, T. E. CAMPBELL,
W. F. MANN, JR., AND B. H. POLMER

U.S. Department of Agriculture
Forest Service
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Southern
Forest
Experiment
Station

Summary

The system of equations presented here uses diameter distribution and tree taper functions to forecast in detail the development of unthinned slash pine plantations. The area considered includes the parts of east Texas, central Louisiana, and southern Mississippi where slash pine is planted. Only plantations established on cutover sites that did not require preparation were sampled. However, the results should serve as interim guides for yields in plantations where site preparation is employed. Three sets of yield tables are given, corresponding to predictions made from the site index, plantation age, and: (1) number of trees surviving, (2) number of trees planted and an ideal survival pattern, or (3) number of trees planted and a typical successful survival pattern.

New techniques are presented for predicting crown ratio by d.b.h. class which can be used in selecting among a set of taper curves and to enhance the description of the stand. The computer program USLYCOWG (unthinned slash and loblolly yields for cutover sites in the West Gulf region) that produces the yield tables can be obtained from the authors.

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The computer routines developed by Robert L. Bailey and described in Research Papers SO-96 and 97 provided a framework for the system reported here. Our efforts were also facilitated by information and computer routines provided by F. Thomas Lloyd and Edward W. Whitehorne of the Southeastern Forest Experiment Station.

1979

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Yields of Unthinned Slash Pine Plantations on Cutover Sites in the West Gulf Region

By

T. R. DELL, D. P. FEDUCCIA, T. E. CAMPBELL,
W. F. MANN, JR., AND B. H. POLMER

The western limit of the natural range of slash pine (*Pinus elliottii* var. *elliottii* Englm.) is from about 125 miles north of the Mississippi Gulf coast and west to the Tickfaw River in southeast Louisiana. The range was extended to about 250 miles inland and almost to the western edge of the pine belt in east Texas during the reforestation effort that began in the late 1930's. Since then, slash plantations have been established on about 2.5 million acres in the western part of the natural range and westward through east Texas. Previously, the only comprehensive yield tables for unthinned slash plantations that specifically included the West Gulf region were in Coile and Schumacher (1964). The system of equations presented here improves forecasts of detailed plantation development by using diameter distributions and stem taper functions.

The data in this study were collected from plantations on problem-free cutover forest sites. The virgin stands were clearcut and grazing with repeated burning controlled woody vegetation, which allowed successful establishment of planted pines without mechanical site preparation.

Many such problem-free sites should be available in the future as pine density is carefully controlled throughout the rotation and utilization is more complete at final harvest. Thus, our results may apply to repeated crops of pines in the region. Also, the results can be used—at least until better guides are published—to predict yields where site preparation is employed. Yield forecasts by various systems including the one presented here were used by Clutter and Dell (1978) to anticipate yield with site preparation.

In the text that follows we will explain the equations used in the system. Some readers may want to apply our system to circumstances not covered in the yield tables. To do so, the computer program, USLYCOWG (unthinned slash and loblolly yields for cutover sites in the West Gulf region), which is written in FORTRAN, is available from the Southern Forest Experiment Station, Statistical Methods for Research and Application, T-10210, 701 Loyola Ave., New Orleans, LA 70113. A companion publication that presents yields for loblolly pine is in preparation.

Readers who wish to, can proceed directly to the APPLICATIONS section, which explains how to use the yield tables. First, however, it will be necessary to become familiar with the following notations:

A_P = Plantation age, the number of growing seasons since the seedlings were planted.

H_D = Average height of dominant and codominant trees at any given A_P.

S_I = Site index, the average height of dominant and codominant trees at a given index age (I). In the tables I is a plantation age of 25 years.

T_P = Number of trees planted per acre.

T_S = Number of trees surviving at a given A_P.

Dell is Mathematical Statistician; Feduccia, Research Forester; Campbell, Silviculturist; Mann, Chief Silviculturist; and Polmer, Statistician. All are employed by the Southern Forest Experiment Station, Forest Service – USDA, except Feduccia, who is assigned to the Southern Station by the Louisiana Office of Forestry.

Plantation Data

Study plots were in unthinned slash pine plantations established on cutover forest land. Competing vegetation was not a problem even though planting had been delayed on some areas for up to 20 years. Wildfires burned the idle lands frequently and prevented natural regeneration and hardwood brush invasion. On some areas the heavy grass rough that predominated was burned off before planting; on others it was not. Plots selected in the plantations avoided areas of poor survival and were free of heavy insect, disease, or other damage.

Much of the data used in developing the prediction system were from records on unthinned plots of various sizes in ten long-term stand density studies. Some plots had been remeasured from one to six times at intervals of 1 to 5 years. In addition, 44 supplementary plots were installed to specifically include site, age, and initial planting density combinations not well represented in existing studies. Collectively 399 plot observations were available and their geographic coverage is shown in figure 1. Summaries of the distributions of these observations are given in tables 1 through 3.

For each observation, the heights of at least 10 dominant and codominant trees were obtained to determine site index. Diameter at breast height (d.b.h.) to the nearest 0.1 inch was measured for each tree on the plot. In addition, measurements were made on individual volume sample trees relating to total height, height to the base of the living crown, and upper stem outside bark diameters. However, these data were not consistently available for all plots.

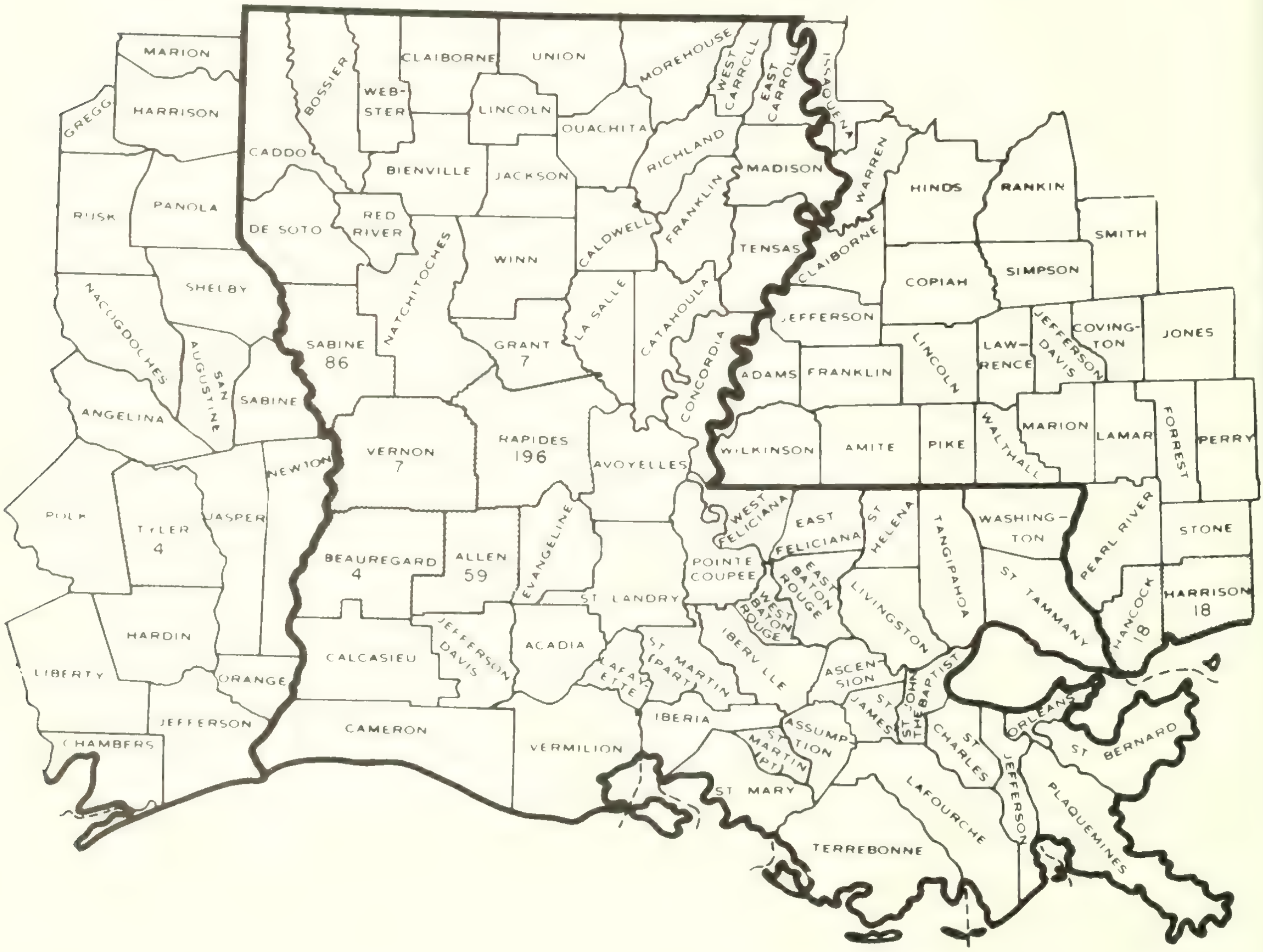

Figure 1.—*Geographic location of 399 plot observations with number of observations by county or parish.*

Table 1.—*Distribution of observation points by plantation age and planting density*

Age class	Planting density range (trees per acre)									Total
	250-500	501-750	751-1000	1001-1250	1251-1500	1501-1750	1751-2000	2001-2250	2251-2500	
Years	*Number of points*									
3-7	—	—	15	—	—	—	—	—	—	15
8-12	—	6	57	33	—	—	—	—	—	96
13-17	8	8	113	47	2	12	—	2	12	204
18-22	—	7	23	11	3	5	—	—	—	49
23-27	—	6	16	5	—	—	—	—	—	27
28-32	—	—	6	2	—	—	—	—	—	8
Total	8	27	230	98	5	17	0	2	12	399

Table 2.—*Distribution of observation points by plantation age and site index*

Age class	Site index class													Totals
	23-27	28-32	33-37	38-42	43-47	48-52	53-57	58-62	63-67	68-72	73-77	78-82	83-87	
Years	Number of points													
3-7	—	—	—	—	—	—	—	—	—	9	—	6	—	15
8-12	1	—	3	2	4	4	—	3	8	31	26	12	2	96
13-17	—	—	—	—	8	10	24	17	47	54	41	3	—	204
18-22	—	—	—	—	1	6	13	14	8	7	—	—	—	49
23-27	—	—	—	—	—	9	6	4	1	7	—	—	—	27
28-32	—	—	—	—	—	—	—	—	4	2	2	—	—	8
Totals	1	—	3	2	13	29	43	38	68	110	69	21	2	399

Table 3.—*Distribution of observation points by planting density and site index*

Planting density class	Site index class													Totals
	23-27	28-32	33-37	38-42	43-47	48-52	53-57	58-62	63-67	68-72	73-77	78-82	83-87	
No. of trees	*Number of points*													
250-500	—	—	—	—	3	2	3	—	—	—	—	—	—	8
501-750	—	—	—	—	—	2	12	6	1	4	2	—	—	27
751-1000	1	—	3	2	10	22	25	19	38	65	26	18	1	230
1001-1250	—	—	—	—	—	3	2	8	19	23	39	3	1	98
1251-1500	—	—	—	—	—	—	—	—	2	3	—	—	—	5
1501-1750	—	—	—	—	—	—	1	3	4	9	—	—	—	17
1751-2000	—	—	—	—	—	—	—	—	—	—	—	—	—	0
2001-2250	—	—	—	—	—	—	—	—	—	1	1	—	—	2
2251-2500	—	—	—	—	—	—	—	2	4	5	1	—	—	12
Totals	1	—	3	2	13	29	43	38	68	110	69	21	2	399

Model Development

Site Index

Bailey and others (1973) concluded that the pattern in average heights of dominant and codominant trees with age for slash pine in Miscellaneous Publication 50 (USDA Forest Service 1929) was very similar to the trend in the plantations on which this paper is based. Farrar (1973) facilitated computations with the 1929 results by providing equations to represent the guide curves and to allow substitution of different index ages. His equation for slash pine is:

$$H_D = (S_I)(10)^{[-8.80405(\frac{1}{AGE} - \frac{1}{I}) + 22.7952((\frac{1}{AGE})^2 - (\frac{1}{I})^2)]}.$$

In our paper a reference age of 25 years is used, but the computer routines allow substitution of any index age.

Our entry for AGE in the above is A_P. Misc. Publ. 50 was based upon age from seed, so it seems logical that the age entry should be $A_P + 1$ because one-year-old stock is planted. (The corresponding index age would be 26 years.) However, if $A_P + 1$ is used in the above equation the height-age trend does not track the observed values very well. The reason probably is that there is a delay in height growth caused by transplanting that nullifies the time in the nursery.

Diameter Distributions

The three parameter Weibull function (Bailey and Dell 1973) was adopted as a model for the distribution of diameters. The cumulative distribution function (c.d.f.) and the probability density function (p.d.f.) for the Weibull distribution, where x is a specified d.b.h. value and a, b, and c are the parameters to be estimated, are:

c.d.f.:

$$F(x) = 1 - \exp\left[-\left(\frac{x-a}{b}\right)^{c}\right], \text{ for } (a < x < \infty)$$
$$= 0 \text{ otherwise}$$

p.d.f.:

$$f(x) = \frac{c}{b}\left(\frac{x-a}{b}\right)^{c-1} \exp\left\{-\left[\frac{x-a}{b}\right]^{c}\right\}, \text{ for } (a < x < \infty)$$
$$= 0 \text{ otherwise.}$$

In general for this distribution $b > 0$ and $c > 0$ and for the application to the distribution of d.b.h. $a > 0$ is specified.

For each of the 399 plots, counts by one-inch d.b.h. classes on a plot basis were used to obtain estimates of the three parameters. The fitted plot parameters were then used as dependent variables for developing the following multiple regression equations to predict values of the diameter distribution parameters as functions of H_D, T_S, and A_P.

$$a = 1.3986 + 2.9217 \log\text{[1]}(H_D) - 1.8477 \log(A_p) - 1.1126 \log(T_s)$$
$$R^2 = 0.14,\ S_{y\,\cdot\,x} = 0.3517,$$
$$Y = 0.80,\ S_y^2 = 0.4048$$

$$a + b = 2.5800 + 10.138 \log(H_D) - 2.5005 \log(A_p) - 3.6275 \log(T_s)$$
$$R^2 = 0.93,\ S_{y\,\cdot\,x} = 0.1161,$$
$$\bar{Y} = 5.67,\ S_y^2 = 1.5754$$

$$c = 9.1471 + 6.5959 \log(H_D) - 7.6706 \log(A_p) - 2.4479 \log(T_s)$$
$$R^2 = 0.31,\ S_{y\,\cdot\,x} = 0.6568,$$
$$\bar{Y} = 3.92,\ S_y^2 = 0.9373.$$

The equations for the a and c parameters account for little of the variation. The a or location parameter expresses the smallest d.b.h. that could be encountered and the c parameter relates to the shape of the distribution. Estimates of these parameters vary greatly depending on the occurrence of small trees on the sample plot. On plots having the same site, age, and essentially the same density, the extent to which these weaker trees have been eliminated by competition or fire can vary greatly, which contributes to the difficulty of predicting the location and shape parameters.

Despite the inherent variability, the system of equations adequately defines the diameter distribution trends. Observed and predicted basal areas for the 399 plot observations had a simple correlation of +.94 and the deviations expressed as a percent of the observed value averaged only 1.2 percent under prediction. Of the 399 observations, 240 had predictions that were within ±5 percent of the observed value.

Height-Diameter Relationships

This component predicts the total height of a tree (H_i), given its d.b.h. (D_i) and information on H_D, A_p, T_s, and DMAX. The last is the midpoint of the largest diameter class containing at least one tree per acre, as defined by the Weibull c.d.f. and T_s. Various models were explored for this component but none represented an improvement over that used by Smalley and Bailey (1974). We did not evaluate, however, a model provided very recently by Clutter and Belcher (1977).

The data set for the following equation involved 3,504 individual height-diameter pairs.

$$\log(H_D/H_i) = -0.050341 + (1/D_i - 1/\text{DMAX})\{3.1868 + 1.5708\,A_pT_s(10^{-5}) + 0.0114942\,T_s/A_p - 2.0981 \log(T_s/A_p) + 1.4034 \log(H_D/A_p)\}$$
$$R^2 = 0.84,\ S_{y\,\cdot\,x}^2 = 0.0014,\ Y = 0.0550,$$
$$S_y^2 = 0.0092.$$

For certain combinations the equation predicts H_i values under 4.5 feet. When this happens the height estimate is set at 5 feet by the computer routines used to implement this system of yield predictions.

When the equation was rearranged to predict H_i and applied to the trees from which the coefficients were derived the average value of the deviation (predicted-observed) was −.17 feet, and 96 percent of the variation about mean height was explained.

---

[1] Logarithms to the base 10 and e are denoted respectively by log and *ln*.

Crown Ratio-Diameter Relationships

To predict the ratio of crown length to total height of the tree as a percentage (CR) a component was added in the system to predict the CR_i of a tree of a given D_i growing in a stand with specified values for H_D, A_p, T_s, and the three Weibull parameters of the diameter distribution.

The prediction of CR_i was built upon the following specifications:

(1) $0 < CR_i < 100$

(2) When D_i is equal to the expected value of the diameters ($\bar{D}$) then CR_i must equal the average crown ratio of all trees ($\overline{CR}$)

(3) A monotonic relationship exists such that an increase in the D_i value is associated with an increase in the predicted CR_i.

The related equations are:

$$CR_i = 100\left[1 - \exp\left\{\left(\frac{D_i}{\bar{D}}\right)^{\lambda} ln\left(1 - \frac{\overline{CR}}{100}\right)\right\}\right] \text{where}$$

$$\overline{CR} = 214.60 - 44.814 \log(H_D) - 27.049 \log(A_p) - 23.453 \log(T_s) \text{ and}$$

$$\lambda = 1.9983 - 0.85518 \log(H_D) + 0.43365 \log(A_p) - 0.24879 \log(T_s).$$

$\bar{D} = a + b\,\Gamma(c^{-1} + 1)$ with $\Gamma(z)$ defined as the gamma function $\int_0^\infty t^{z-1}e^{-t}\,dt$ and a, b, c are the Weibull parameters of the diameter distribution.

The equation for $\overline{CR}$ was based upon a regression fitting with 120 plot observations and had the following related statistics:

$$R^2 = .802,\ S^2_{y \cdot x} = 9.13,\ \bar{Y} = 39.8, \text{ and}$$
$$S^2_y = 44.89.$$

The coefficients for the equation to predict λ were obtained from a regression that used data from 2353 trees.

Volume-Defining Functions

In this system, to estimate the volume in a tree, an appropriate taper equation is defined and integrated between two points. The taper model was taken from Bennett and others (1978). In their work, separate taper equations for inside and outside bark predictions are defined by two sets of coefficients. Total height and the diameter outside bark at breast height are required for defining the taper equation of a given tree. However, we found in fitting their general model for trees of different crown ratio classes, a pattern of change occurred in some of the coefficients. Thus, given a tree's CR one should be able to obtain a refined taper equation for the tree. To use the technique so that the taper function formulation was not severely complicated, we established three classes of CR values and developed separate sets of inside- and outside-bark taper function coefficients for each of these classes. Our six sets of coefficients are given below along with the two sets published by Bennett and others (1978)[2].

OUTSIDE BARK

Coefficient	SE-176	$CR < 36$	$36 \leq CR < 50$	$CR \geq 50$
B1	16.07190	19.68500	9.14270	6.06270
B2	0.676434	0.520310	1.634400	1.919300
B3	0.00516633	0.015268	−0.041715	−0.068244
B4	−11.73210	−13.06500	−8.58870	−7.18150
ETA	− 0.10970	− 0.135320	−0.13532	−0.13532
G1	0.0	0.0	0.0	0.0
G2	1.0	1.0	1.0	1.0

INSIDE BARK

Coefficient	SE-176	$CR < 36$	$36 \leq CR < 50$	$CR \geq 50$
B1	8.21592	10.99100	2.73910	0.77472
B2	0.676338	0.524640	1.495400	1.610900
B3	0.0100534	0.02250	−0.036476	−0.053570
B4	−5.56717	− 6.63070	−2.87390	−1.80160
ETA	−0.10500	− 0.10943	−0.10943	−0.10943
G1	−0.48497	− 0.48148	−0.48148	−0.48148
G2	0.887077	0.892630	0.892630	0.892630

---

[2] Referred to hereafter as SE-176.

For the three classes of increasing crown ratio we had 1149, 2256, and 379 upper stem outside-bark measurements. We did not have upper stem inside bark data and used the ratio of the inside and outside bark taper functions presented in SE-176, along with our outside-bark observations to estimate corresponding inside-bark diameters for fitting inside bark taper curve above breast height.

The two coefficients in the taper model that relate to the prediction of inside-bark diameter at breast height (G1 and G2) did not differ significantly by crown ratio classes, and the overall estimates based on 50 trees were very close to the ones given in SE-176. The coefficient concerned with the taper function below breast height (ETA) did not differ by crown ratio group for either outside- or inside-bark predictions; thus, pooled estimates of these coefficients based on 110 observations were used.

For given d.b.h., total height, and merchantability specifications, the tree volumes predicted from our sets of coefficients are generally higher than those resulting from the use of SE-176 coefficients. However, for larger trees having crown ratios greater than 50 percent, we predict lower volumes. Crown ratios are larger when trees are open-grown and such trees have more drastic taper in the upper stem, and usually have less volume.

Only one other set of volume functions for planted slash pine in the West Gulf Region intended for use with a wide variety of tree sizes is available (Moehring and others 1973). With their non-form class volume equations for inside and outside bark to various upper stem limits, predicted volumes are generally higher than with the SE-176 equation for all but very small trees. Schmitt and Bower (1970) provided an equation for total inside bark volume based on trees less than 8 inches d.b.h. growing in slash pine plantations of southern Mississippi. Volumes predicted by this equation are higher than those from comparable application of the SE-176 coefficients.

It seems then that West Gulf slash pine tapers less in the upper stem than the eastern slash pine reported in SE-176. We also witnessed more stem swell near the ground, which usually occurs on wetter sites.

Survival Options

The system of equations given thus far allows predictions of detailed stand information by diameter classes, provided one is given T_s, A_p, and S_I. However, some users of this system may not be able to specify T_s, and would have to substitute an estimate of T_s based upon a specified T_p and other information including A_p and perhaps S_I or H_D. It is best to develop one's own survival functions if possible, but we provide two survival functions that can be used when it is not.

Because plots were placed to avoid areas of poor survival and heavy damage, the survival function fitted to these data provides essentially ideal survival patterns. The utility of the function is that it establishes upper limits on expected survivals. Our equation is,

$$\log(T_p/T_s) = A_p\{0.015038 \log(T_p) + 0.00063965\, H_D - 0.0095738\sqrt{H_D}\}$$

$$R^2 = .81,\ S^2_{y \cdot x} = 0.005742,\ \bar{Y} = 0.1497,\ S^2_y = 0.007722.$$

This is the model used by Smalley and Bailey (1974). Our regression was based on 421 plot observations because survival data were obtained for 22 plots beyond the original 399. Tables of yields based on this ideal survival response that use S_I, A_p, and T_p are given in Appendix 2.

Users of the system who require yields predicted on the basis of less than ideal survival, but who do not have data on survival can use the following equation (Coile and Schumacher 1964):

$$\log(T_s) = \log(T_p) + [2.3949 - 1.2505 \log(T_p)]\frac{A_p}{100}.$$

In their study, site index was not significant in survival prediction. Plots were selected to represent typical, successful plantations but no attempt was made to place them in the more ideal locations. This equation predicts survivals that are nearly always below predictions by our equation. Tables of yields using this more conservative survival function are in Appendix 3.

Applications

Yields of unthinned plantations can be forecast if one specifies the S_I, A_p and a factor that expresses stand density. The density can be in terms of T_s or T_p. When the number of trees planted is specified, a prediction of survival is needed. Either of two survival models — corresponding to ideal and typical, successful plantations — can be chosen.

The tables in Appendix 1 are based on S_I, A_p, and T_s. Site index is from 40 through 80 by 10 ft.

intervals. Within each site index group, tables are presented for each of three ages. Finally, within each S_I and A_p combination there are tables corresponding to six levels of T_s. For each S_I, tables for the following combinations are given.

A_p	T_s					
10	400	500	600	800	1000	1300
20	300	400	500	700	900	1100
30	200	300	400	500	600	800

Tables in Appendix 1 are detailed and should satisfy those who can specify T_s either as an objective of their management or as an expectation from their plantation records. Appendix 1 can also be used by one who specifies T_p and is willing to estimate T_s using either of the survival equations given or the corresponding solutions in Appendices 4 and 5.

In Appendix 2 yield tables, T_p is the density and ideal survival is assumed. Site index is 40, 60, and 80 feet; T_p is 500, 750, 1000, and 1500 trees per acre; and A_p is 15, 25, and 35 years. The order of presentation of the tables, in which A_p changes most rapidly, illustrates plantation development in time for a given site and planting density. Appendix 3 is the same as Appendix 2, but the survival model from Coile and Schumacher (1964) is used to define typical survival trends for successful plantations.

After each table are estimates for different variables, including: arithmetic mean d.b.h., the diameter corresponding to the tree of average basal area (quadratic mean diameter), and corresponding site index for base age 50. Also given for each table is an estimate by diameter class of the crown ratio and the parameter, λ, which is concerned with establishing these estimates.

Volume yields on an acre basis are established as follows:

1. Estimate the number of trees per acre in each one-inch diameter class using T_s and Weibull parameter values.
2. Use midpoint diameter for each class to estimate total height and crown ratio.
3. Compute volume of the midpoint tree using appropriate specifications and taper curve as determined by variables above.
4. Multiply volume in the midpoint tree of the class by number of trees per acre in the class.
5. Sum across the diameter classes.

The tables express the limits of combinations of site, age, and density beyond which the predictions will be questionable.

Trends

The following discussion of trends is limited to data predicted on the basis of the ideal survival model. Figures 2 to 9 show trends for a planting density of 750 stems per acre, or about a 7- by 8-foot spacing, for sites 40 through 80 feet. Graphs are extended 8 years beyond the oldest sampled stand. Trends related to other circumstances can be obtained from the tables or by using the computer routines.

Survival

On all sites, survival percentage decreased as age increased (fig. 2). At age 10, survival declined with decreasing site index. However, because of intense competition on the better sites with advancing age, survival after 32 years was highest on the poorest sites (sites 40 and 50).

Total and Merchantable Yields

Cubic-foot yields (o.b.) per acre for the entire stem of all trees (total yield) and for trees in the 5-inch d.b.h. class and larger to an o.b. top of 4 inches (merchantable yield) increased with site index (figs. 3 and 4). Total and merchantable yield tend to culminate at age 30 to 35 on sites 70 and 80.

Mean Annual Increment

For total volume, age at culmination of mean annual increment (MAI) increased as site index decreased. Culmination was at about 17 years on the best site and was at age 30 on the poorest site (fig. 5). MAI for merchantable volume culminated later than for total volume, for example, age 19 for site 80 and about 32 for site 40 (fig. 6).

Basal Area

Basal area of all trees increased directly with site (fig. 7). Culmination occurred between ages 23 on the best sites and 35 years on site 50. On the poorest site, basal area was still increasing at age 40.

Quadratic Mean Diameter

A 10-foot increase in site index resulted in an average gain of 0.7 inch in mean stand diameter (fig. 8). After age 25, diameter increase tended to be linear. However, to evaluate the effects of site, age, and initial planting density, diameter distributions are more useful than mean diameter.

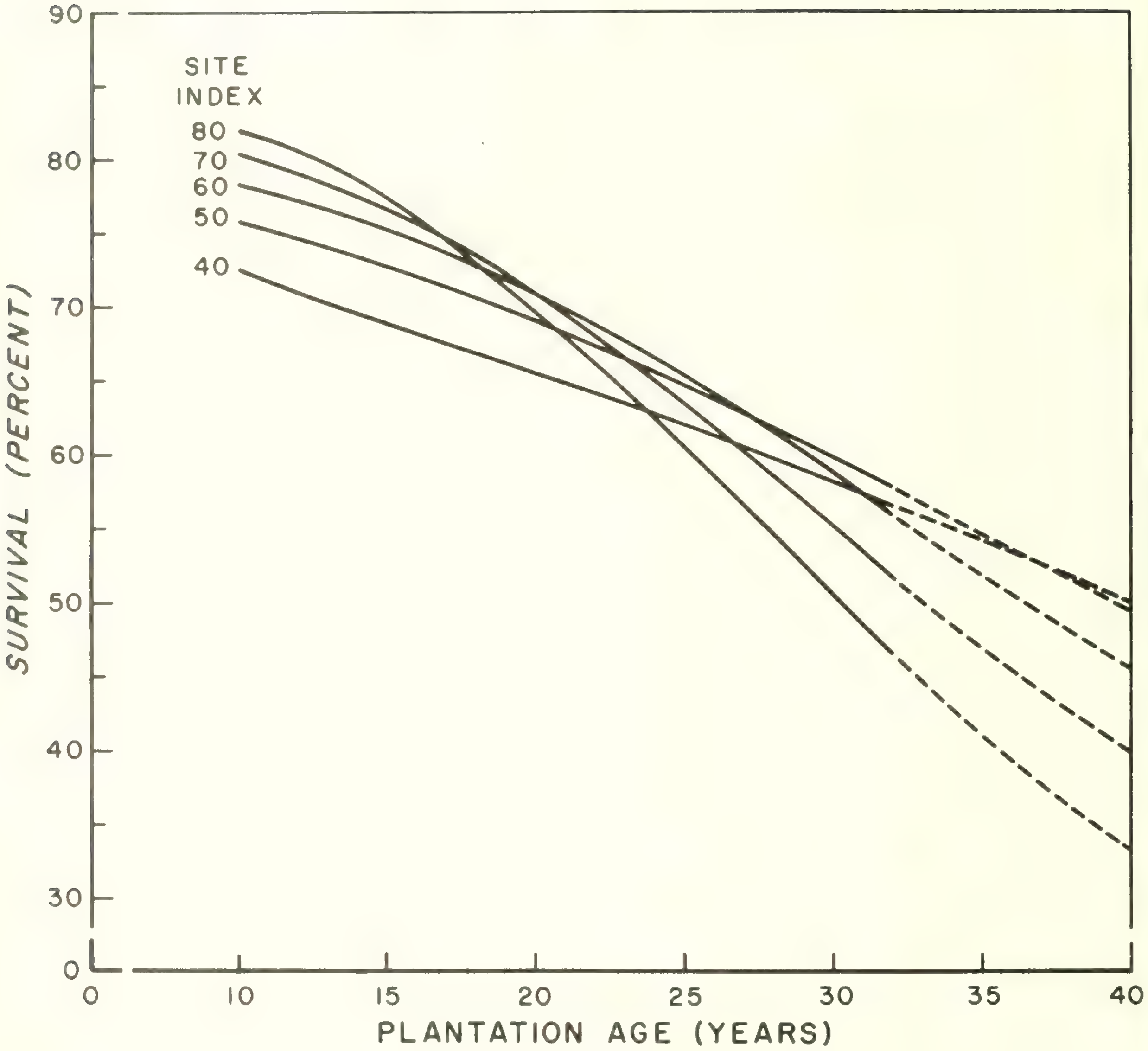

Figure 2.—*Survival from age 10 to 40 years by site index classes.*

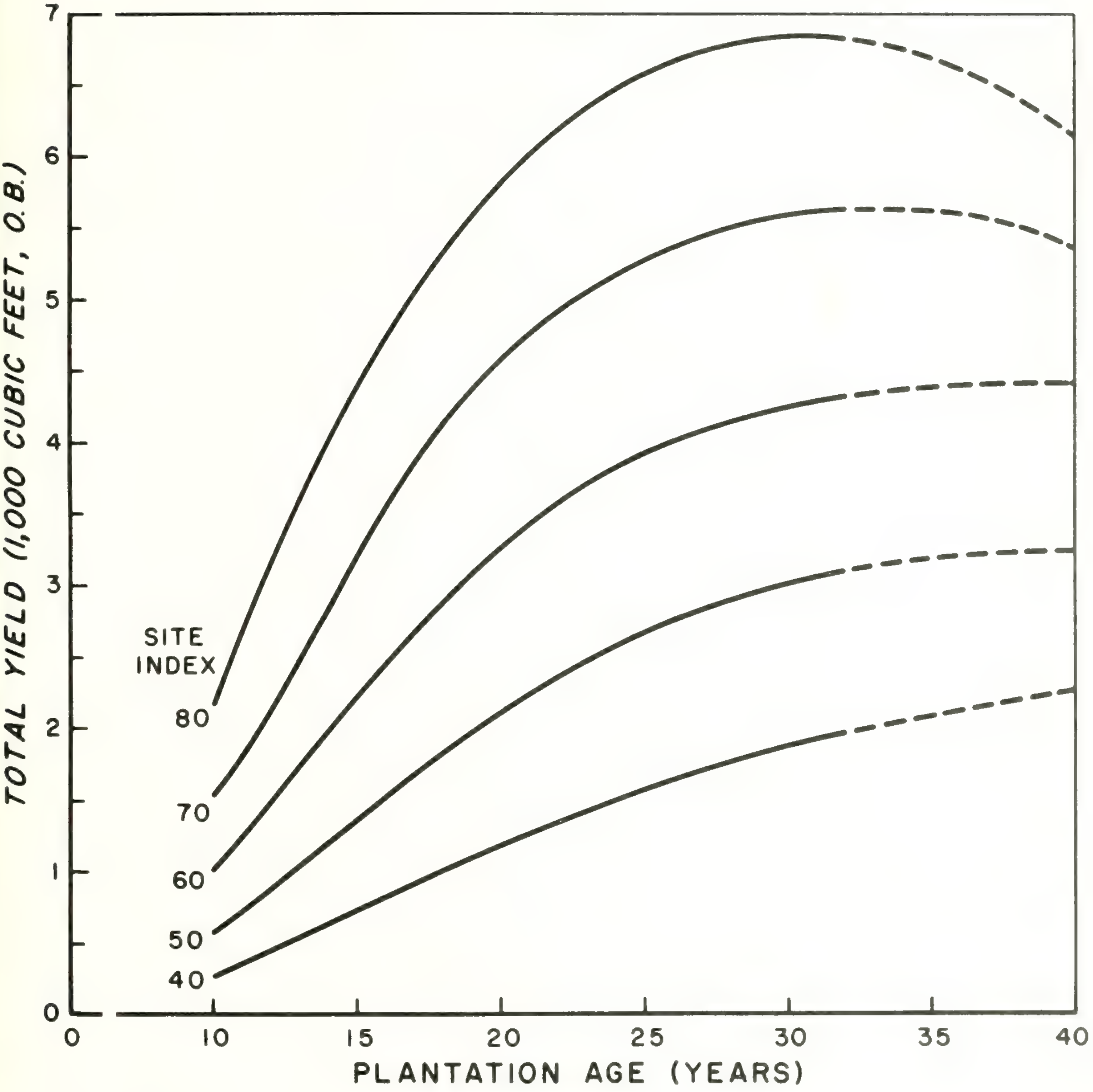

Figure 3.—*Total yield per acre of all trees from ages 10 to 40 years by site index classes.*

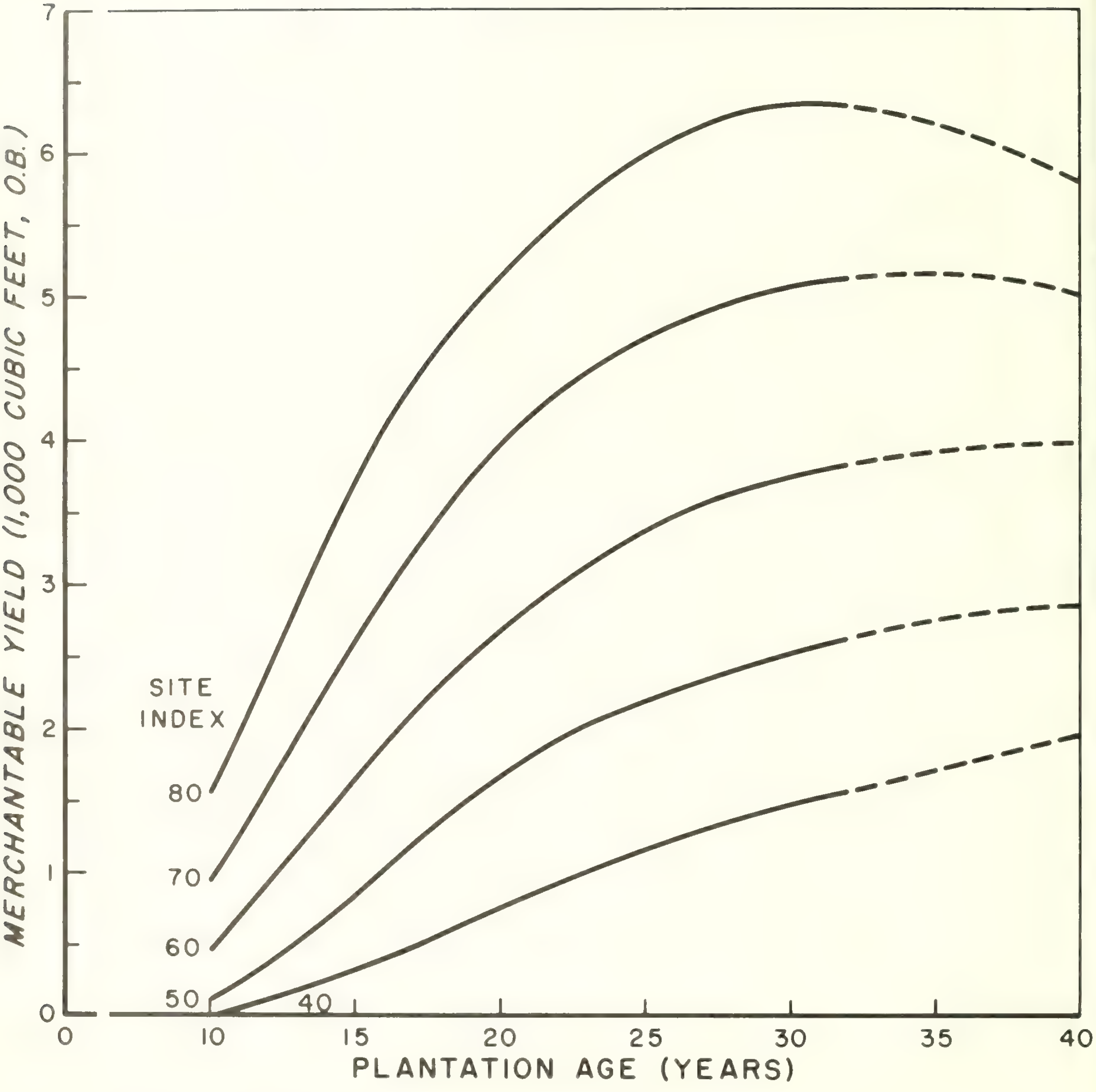

Figure 4.—*Merchantable yield per acre of trees over 4 inches d.b.h. to 4 inches top diameter (o.b.) from age 10 to 40 years by site index classes.*

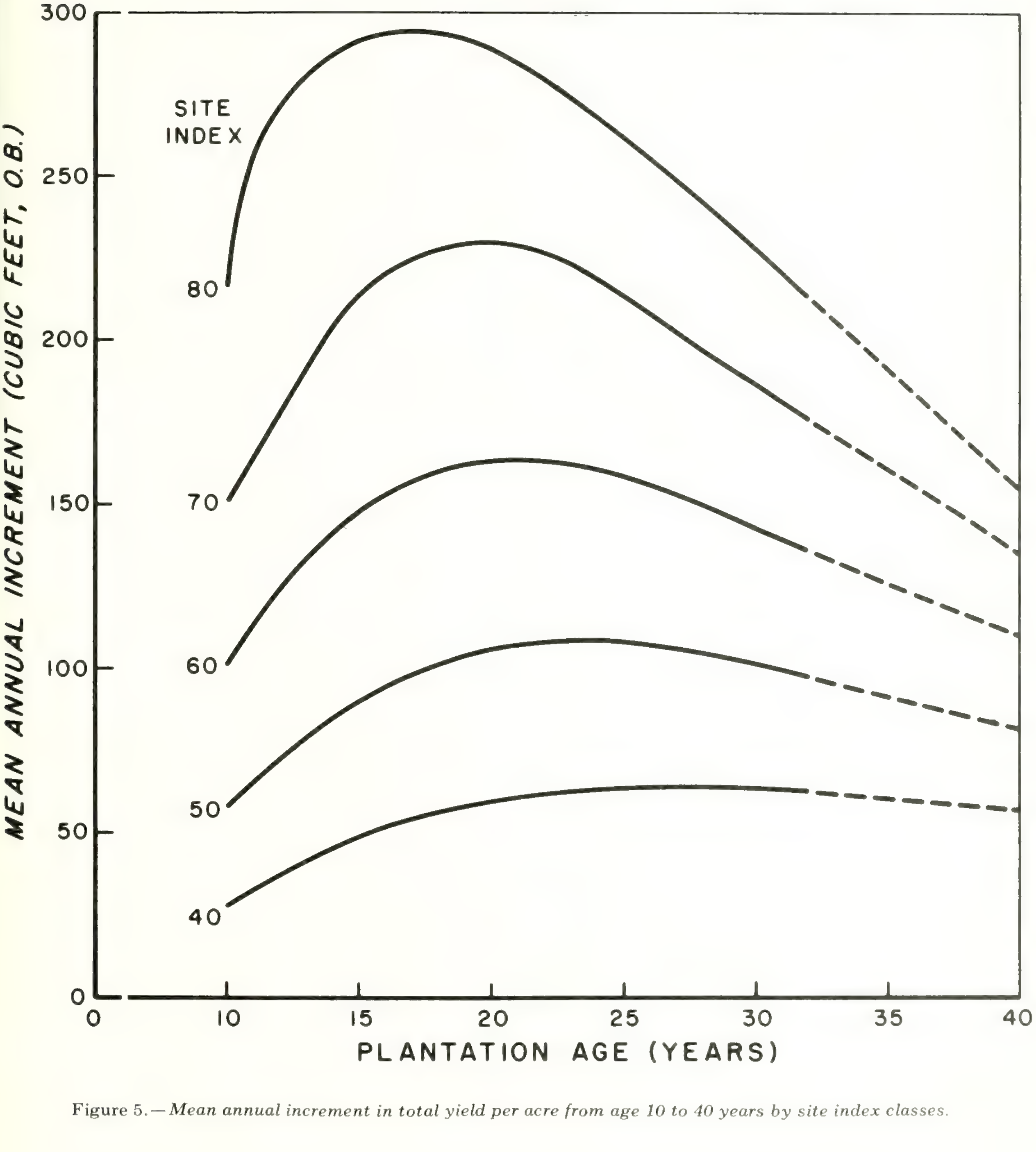

Figure 5.—*Mean annual increment in total yield per acre from age 10 to 40 years by site index classes.*

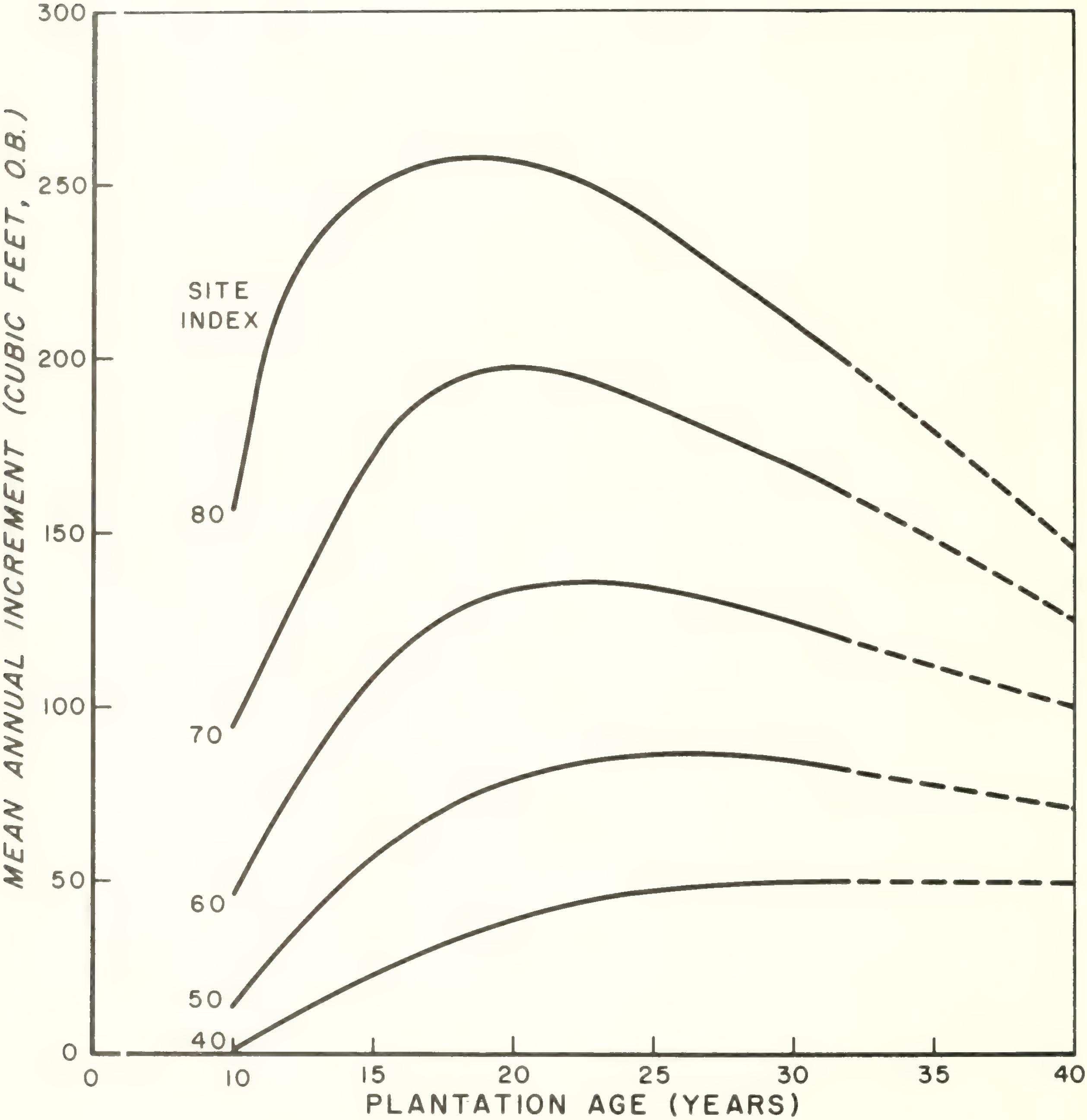

Figure 6.—*Mean annual increment in merchantable yield per acre from age 10 to 40 years by site index classes.*

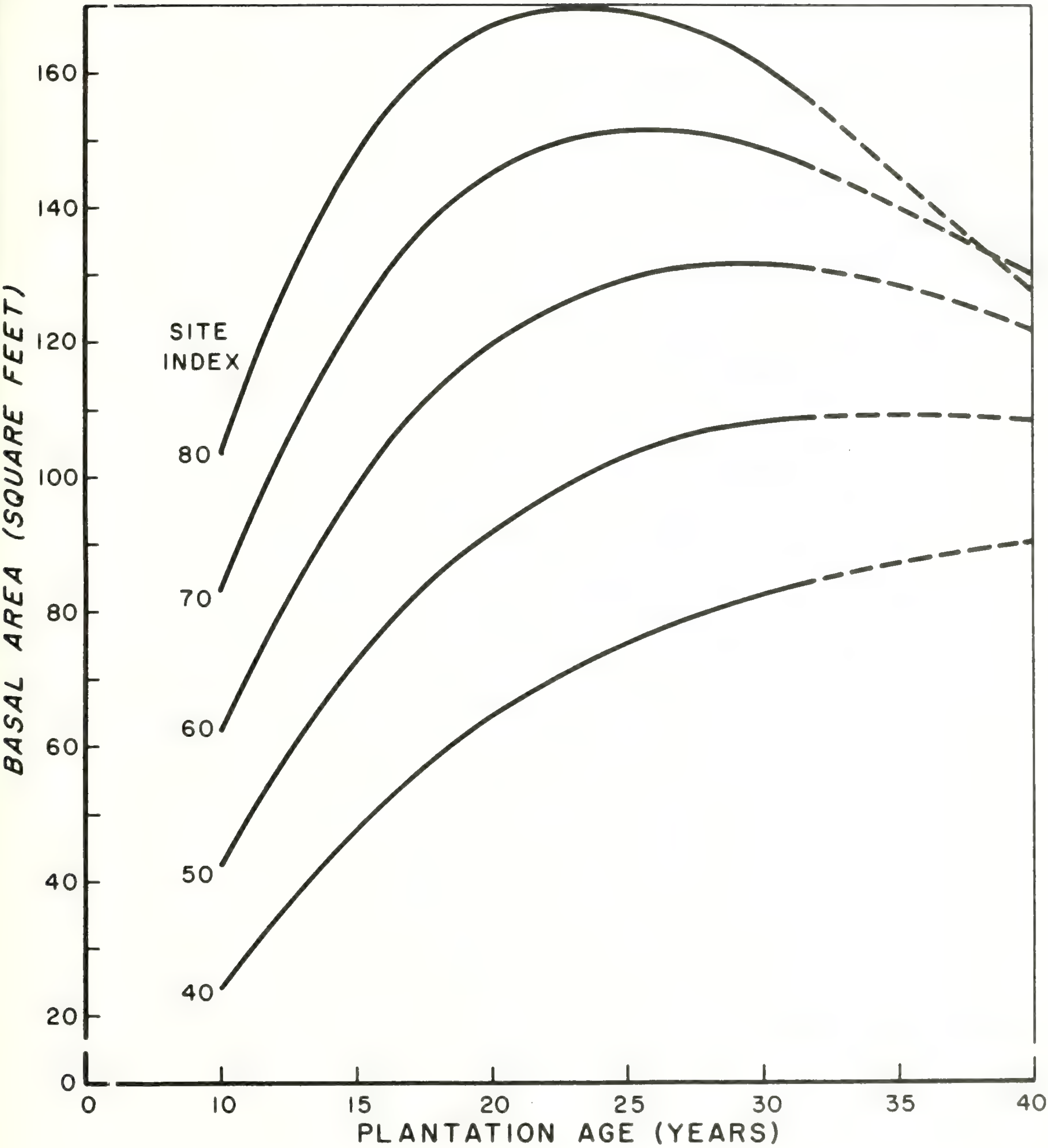

Figure 7.—*Total basal area per acre from age 10 to 40 years by site index classes.*

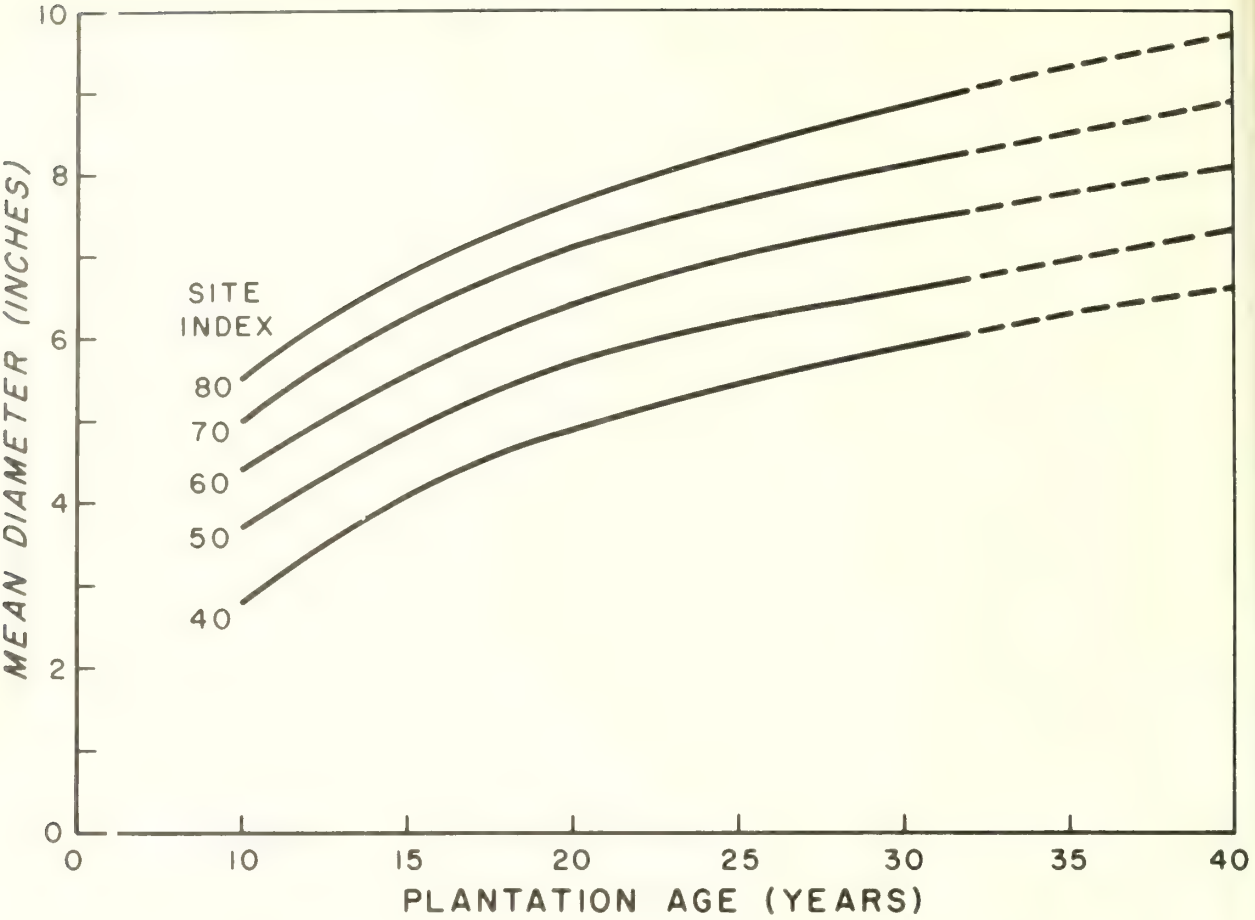

Figure 8.—*Average stand diameter from age 10 to 40 years by site index classes.*

Mean Crown Ratio

The percentage of the tree in live crown declined with age and increasing site index (fig. 9). A mean crown ratio of 35 percent was attained about 10 years earlier on site 80 than on site 50.

Validation and Extensions

Each of the equations presented here was validated by evaluation of trends in deviations between predicted and observed values for the observations upon which they were based. Also, graphs were developed to assure that the predictions were reasonable. These checks were reassuring, but comprehensive validation must be based on independent data. Assistance in compiling such data has been offered by cooperating organizations, and the results will be available in the future.

Some of our unthinned plots were remeasured after the system was developed, and the data are of use in validation. Sixty-eight new observations were available for site indices from 28-87, planting densities of 302-1690 trees per acre, and survival of 176 to 827 trees per acre. Some of the new observations involved older plantations (33 to 36 years old) than were available for the development of the system and provide a check on the predictions for these ages.

For each new plot, observed values of selected variables were compared with predictions from the system. For each variable, the correlation of observed and predicted values was computed along with the mean percent deviation, which is the average of the values for 100 (predicted-observed)/observed. The following results were based on predictions for which the number of surviving trees is known.

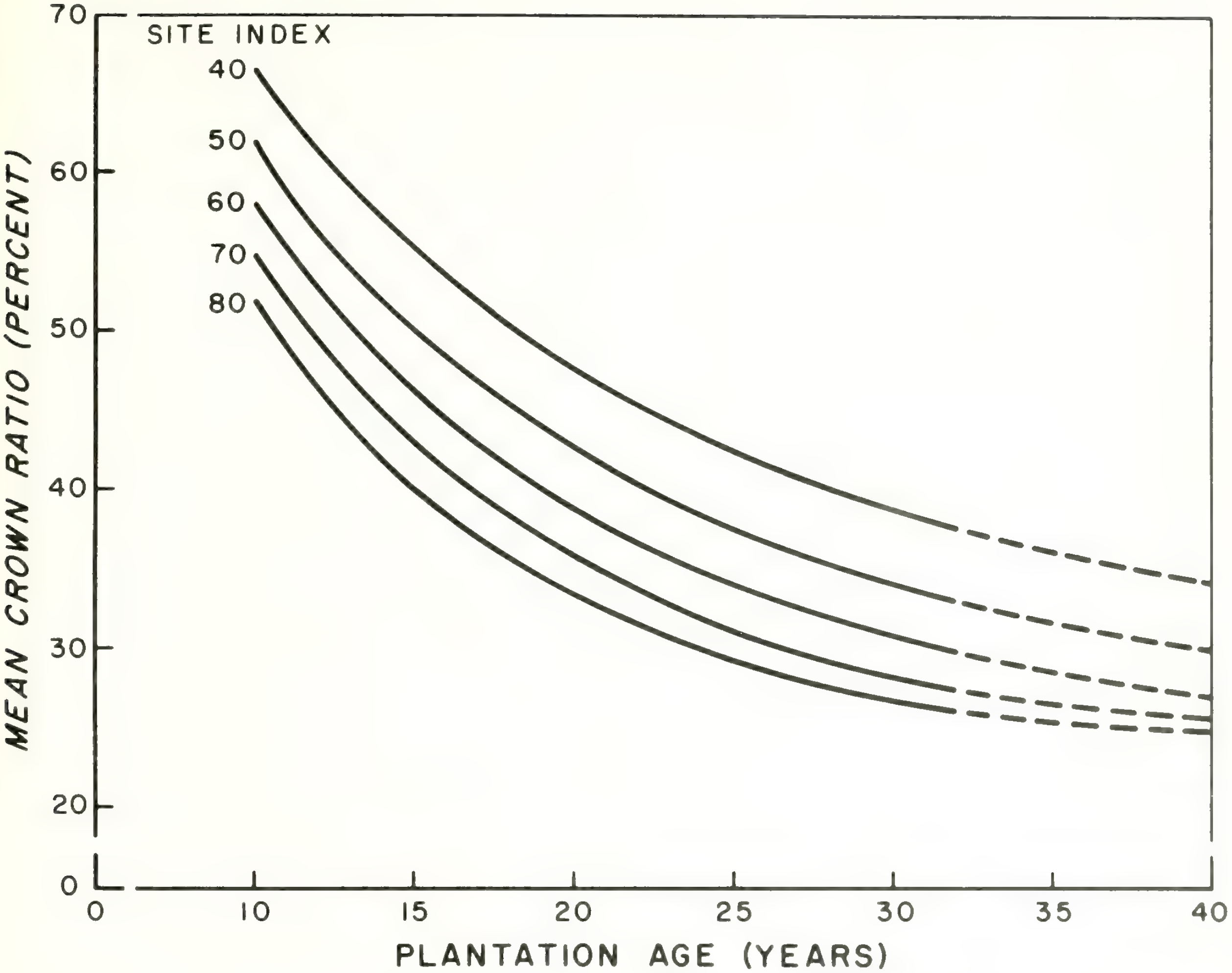

Figure 9.—*Mean crown ratio from age 10 to 40 years by site index classes.*

Variable	r	Mean Percent Deviation
Quadratic mean d.b.h.	+.95	—0.8
Basal area	+.95	—1.1
Total volume o.b.	+.96	+1.2
Merchantable volume o.b.	+.97	—0.8

Since the volume yields on the validation plots were determined by a process that did not use the taper curves (Lohrey and Dell 1969), the results support the validity of the volume-defining component. When the deviations were summarized separately by age classes there seemed to be a shift toward more frequent underprediction of basal areas and volumes for ages beyond 25 years. It is likely that this is related to the difficulty of predicting the location and shape parameters of the diameter distribution.

A similar comparison was made of observed and predicted values when the predictions were based on T_p and the ideal survival model:

Variable	r	Mean Percent Deviation
Quadratic mean d.b.h.	+.94	— 4.3
Basal area	+.83	+ 8.8
Total volume o.b.	+.89	+11.2
Merchantable volume o.b.	+.92	+ 5.8
Number of surviving trees	+.60	+19.7

The results are respectable, considering that at times developments at age 36 were being predicted from the number of trees planted. The bias is caused by a lower number of witnessed survivals on the remeasurement plots than are predicted by the ideal survival model. Obviously plots initially selected for ideal survival tend to fall below this as time passes and mishaps occur.

The corresponding comparison, using predictions based on trees planted and the typical plantation survival model, is summarized below. There is no distinct pattern of bias and the predictions are nearly as close as when current surviving number of trees is known.

Variable	r	Mean Percent Deviation
Quadratic mean d.b.h.	+.93	− .4
Basal area	+.79	−1.3
Total volume o.b.	+.87	+1.4
Merchantable volume o.b.	+.90	−1.0
Number of surviving trees	+.56	+ .8

Yield predictions are sensitive to alterations of the survival models and users of this system should apply one appropriate to their situation. Generally, changes in survival patterns will be the most obvious and easily quantified differences caused by cultural alternatives. Thus, an initial approximation of their impact on yields could be obtained by substituting survival models.

The equations of this system can be used with modifications and extensions of the existing computer routines to predict yields: (1) with other limits of merchantability and stump height than presented here, (2) in metric units, (3) on the basis of weight, and (4) with multiproduct processing. The system is to be the foundation on which components for predicting results with thinning will be developed from currently available data.

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Appendix 1.

Yield tables given site index, age, and number of surviving stems.

YIELDS GIVEN T_S —

A_P 10

S_I 40

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                                                               -------------------------CUBIC FOOT VOLUME-------------------------
GROWING                                                        ALL TREES     5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET,
SEASONS  AV.           STEMS                                   GROUND        FOR O.B. TOPS OF --
SINCE    D+C   DBH     PER      BASAL    CR     AV.            TO TIP         2 INCHES          3 INCHES          4 INCHES
EST.     HT.           ACRE     AREA            HT.           O.B.   I.B.    O.B.   I.B.       O.B.   I.B.       O.B.   I.B.
-----------------------------------------------------------------------------------------------------------------------------
 10       18     1      13        .1     41      5              0      0
                 2      84       1.8     58     12             17      7
                 3     161       7.9     69     16             88     45
                 4     115      10.0     76     18            122     70
                 5      26       3.5     81     20             47     29      41     26         39     24         32     20
                 6       1        .2     85     21              3      2       2      2          2      2          2      1
                       ----    ------                         -----  -----   -----  -----      -----  -----      -----  -----
                       400      23.6                          277    153      43     28         41     26         34     21

     ARITH. MEAN DBH=  3.2 ,     QUADRATIC MEAN DBH=  3.3 ,     WEIBULL PARAMETERS A=  .4 ,  B=  3.12 ,  C= 3.45
                                       MEAN CROWN RATIO= 69.8 ,      LAMPDA=  .703
                                     CORRESPONDING SITE INDEX FOR BASE AGE 50= 56



 10       18     1      34        .2     43      6              1      0
                 2     151       3.3     59     13             32     13
                 3     204      10.0     69     17            115     59
                 4      97       8.5     76     19            106     61
                 5      14       1.9     81     21             26     16      23     15         22     14         17     11
                       ----    ------                         -----  -----   -----  -----      -----  -----      -----  -----
                       500      23.9                          280    149      23     15         22     14         17     11

     ARITH. MEAN DBH=  2.8 ,     QUADRATIC MEAN DBH=  3.0 ,     WEIBULL PARAMETERS A=  .2 ,  B=  2.87 ,  C= 3.22
                                       MEAN CROWN RATIO= 67.5 ,      LAMBDA=  .678
                                     CORRESPONDING SITE INDEX FOR BASE AGE 50= 56



 10       18     1      71        .4     44      7              3      0
                 2     223       4.9     60     14             49     19
                 3     222      10.9     70     17            126     64
                 4      76       6.6     76     19             83     48
                 5       8       1.1     81     21             15      9      13      8         12      8         10      6
                       ----    ------                         -----  -----   -----  -----      -----  -----      -----  -----
                       600      23.9                          276    140      13      8         12      8         10      6

     ARITH. MEAN DBH=  2.5 ,     QUADRATIC MEAN DBH=  2.7 ,     WEIBULL PARAMETERS A=  .2 ,  B=  2.67 ,  C= 3.02
                                       MEAN CROWN RATIO= 65.7 ,      LAMBDA=  .659
                                     CORRESPONDING SITE INDEX FOR BASE AGE 50= 56
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                                                                 -------------------------CUBIC FOOT VOLUME-----------------------
GROWING                                                          ALL TREES           5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET,
SEASONS  AV.           STEMS                                      GROUND             FOR O.B. TOPS OF --
 SINCE   D+C    DBH    PER      BASAL     CR     AV.              TO TIP              2 INCHES            3 INCHES            4 INCHES
  EST.   HT.           ACRE     AREA             HT.             O.B.   I.B.         O.B.   I.B.        O.B.   I.B.         O.B.   I.B.
--------------------------------------------------------------------------------------------------------------------------------------
   10      18     1     197      1.1     46      7                 8      1
                  2     349      7.6     61     14                77     31
                  3     209     10.3     71     17               118     61
                  4      42      3.7     77     19                46     27
                  5       3       .4     82     21                 6      3           5      3            5      3            4      2
                       ----   ------                            -----  -----       -----  -----        -----  -----        -----  -----
                        800     23.0                             255    123           5      3            5      3            4      2

         ARITH. MEAN DBH=  2.1 ,     QUADRATIC MEAN DBH=  2.3 ,     WEIBULL PARAMETERS A=   .0 ,  B=  2.36 ,  C= 2.72
                                          MEAN CROWN RATIO= 62.8 ,       LAMBDA=  .628
                                        CORRESPONDING SITE INDEX FOR BASE AGE 50= 56



   10      18     1     343      1.9     47      6                13      2
                  2     433      9.4     62     13                92     36
                  3     192      9.4     71     17               109     56
                  4      30      2.6     77     19                33     19
                  5       2       .3     81     21                 4      2           3      2            3      2            2      2
                       ----   ------                            -----  -----       -----  -----        -----  -----        -----  -----
                       1000     23.6                             251    115           3      2            3      2            2      2

         ARITH. MEAN DBH=  1.9 ,     QUADRATIC MEAN DBH=  2.1 ,     WEIBULL PARAMETERS A=   .0 ,  B=  2.11 ,  C= 2.48
                                          MEAN CROWN RATIO= 60.5 ,       LAMBDA=  .604
                                        CORRESPONDING SITE INDEX FOR BASE AGE 50= 56



   10      18     1     613      3.3     48      5                21      3
                  2     506     11.0     62     12               103     41
                  3     160      7.9     71     16                87     45
                  4      20      1.7     76     19                22     13
                  5       1       .1     81     21                 2      1           2      1            2      1            1      1
                       ----   ------                            -----  -----       -----  -----        -----  -----        -----  -----
                       1300     24.1                             235    103           2      1            2      1            1      1

         ARITH. MEAN DBH=  1.6 ,     QUADRATIC MEAN DBH=  1.8 ,     WEIBULL PARAMETERS A=   .0 ,  B=  1.83 ,  C= 2.20
                                          MEAN CROWN RATIO= 57.8 ,       LAMBDA=  .575
                                        CORRESPONDING SITE INDEX FOR BASE AGE 50= 56
```

YIELDS GIVEN T_S –

A_P 20

S_I 40

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
20	34	1	1	.0	23	5	0	0						
		2	9	.2	33	11	2	1						
		3	29	1.4	40	19	18	9						
		4	53	4.6	46	24	70	41						
		5	[illegible]	9.8	51	28	165	104	149	96	139	90	107	68
		6	[illegible]	13.0	55	31	238	157	219	147	211	142	191	129
		7	44	11.8	59	34	233	159	217	150	212	147	202	140
		8	20	7.0	62	36	145	101	136	96	134	94	129	92
		9	6	[illegible]	64	37	56	40	53	38	52	37	51	37
		10	1	.5	67	38	12	8	11	8	11	8	11	8
			[illegible]	50.9			939	620	785	535	759	518	691	474

ARITH. MEAN DBH= 5.4 , QUADRATIC MEAN DBH= 5.6 , WEIBULL PARAMETERS A= .7 , B= 5.18 , C= 3.23
MEAN CROWN RATIO= 52.5 , LAMBDA= .634
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

20	34	1	3	.0	23	5	0	0						
		2	23	.5	33	13	6	2						
		3	55	2.7	40	[illegible]	37	19						
		4	84	7.3	45	26	117	69						
		5	94	12.8	50	30	231	147	211	136	196	127	153	99
		6	74	14.5	54	32	273	181	252	169	243	164	219	148
		7	43	11.5	57	34	228	155	212	146	207	143	197	137
		8	18	6.3	60	36	130	91	122	86	120	85	117	82
		9	5	2.2	63	37	47	33	44	31	43	31	42	31
		10	1	.5	65	38	12	8	11	8	11	8	11	8
			400	59.4			1081	705	852	576	820	558	739	505

ARITH. MEAN DBH= 4.9 QUADRATIC MEAN DBH= 5.2 , WEIBULL PARAMETERS A= .6 , B= 4.86 , C= 2.92
MEAN CROWN RATIO= 49.6 , LAMBDA= .603
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

20	34	1	9	.0	23	[illegible]	0	0						
		2	43	.9	33	15	13	5						
		3	[illegible]	4.2	39	22	59	31						
		4	[illegible]	9.7	45	27	159	95						
		5	108	14.7	49	30	265	169	242	156	225	146	175	113
		6	78	15.3	53	33	295	196	273	183	263	177	237	160
		7	42	11.2	56	35	228	156	212	147	208	144	198	137
		8	17	5.9	59	36	123	86	115	81	114	80	110	78
		9	7	2.2	[illegible]	37	47	33	44	31	43	31	42	31
		10	1	.5	63	[illegible]	12	8	11	8	11	8	11	8
			500	64.8			1201	779	897	606	864	586	773	527

ARITH. MEAN DBH= 4.6 QUADRATIC MEAN DBH= 4.9 , WEIBULL PARAMETERS A= .5 , B= 4.62 , C= 2.68
MEAN CROWN RATIO= 47.3 , LAMBDA= .579
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
20	34	1	35	.2	24	6	1	0						
		2	99	2.2	32	17	32	14						
		3	146	7.2	39	24	106	56						
		4	155	13.5	44	28	228	136						
		5	124	16.9	48	31	312	199	286	185	265	173	197	127
		6	79	15.5	51	34	306	203	283	191	273	185	245	166
		7	40	10.7	54	35	217	148	202	140	198	137	188	131
		8	16	5.6	57	37	119	83	111	78	110	78	106	75
		9	5	2.2	59	38	48	34	45	32	44	32	44	31
		10	1	.5	61	38	12	8	11	8	11	8	11	8
			700	74.5			1381	881	938	634	891	613	791	538

ARITH. MEAN DBH= 4.1 , QUADRATIC MEAN DBH= 4.4 , WEIBULL PARAMETERS A= .3 , B= 4.25 , C= 2.32
MEAN CROWN RATIO= 43.9 , LAMBDA= .542
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	I.B.	2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
20	34	1	87	.5	24	7	4	1						
		2	164	3.6	32	17	53	22						
		3	194	9.5	38	24	141	75						
		4	177	15.4	43	28	261	156						
		5	130	17.7	46	31	328	209	299	194	278	181	206	133
		6	79	15.5	50	33	304	202	281	189	272	183	245	166
		7	41	11.0	52	35	222	152	207	143	203	140	193	134
		8	18	6.3	55	36	130	91	122	86	120	85	117	82
		9	7	3.1	57	37	65	46	61	44	61	44	59	43
		10	2	1.1	59	38	23	17	22	16	22	16	22	16
		11	1	.7	61	38	14	10	13	10	13	10	13	10
			900	84.3			1545	981	1005	682	969	659	[illegible]	584

ARITH. MEAN DBH= 3.7 , QUADRATIC MEAN DBH= 4.1 , WEIBULL PARAMETERS A= .2 , B= 3.98 , C= 2.06
MEAN CROWN RATIO= 41.4 , LAMBDA= .515
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	I.B.	2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
20	34	1	166	.9	24	7	7	1						
		2	226	4.9	32	17	73	31						
		3	232	11.4	37	24	169	89						
		4	190	16.6	42	28	280	167						
		5	132	18.0	45	31	333	212	304	197	283	194	[illegible]	[illegible]
		6	80	15.7	48	33	308	204	285	192	275	186	248	[illegible]
		7	42	11.2	51	35	228	155	212	147	209	[illegible]	[illegible]	[illegible]
		8	20	7.0	53	35	145	101	136	96	134	94	[illegible]	92
		9	8	3.5	55	37	75	53	70	50	68	50	68	[illegible]
		10	3	1.6	57	38	35	25	33	24	33	24	32	24
		11	1	.7	59	38	14	10	13	10	13	10	13	10
			1100	91.5			1667	1049	1053	716	1015	692	[illegible]	615

ARITH. MEAN DBH= 3.4 , QUADRATIC MEAN DBH= 3.9 , WEIBULL PARAMETERS A= .1 , B= 3.76 , C= 1.84
MEAN CROWN RATIO= 39.3 , LAMBDA= .494
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

YIELDS GIVEN T_S –

A_P 30

S_I 40

GROWING SEASONS SINCE FST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O B.	I.B	O.B.	I.B.
30	45	2	3	.1	25	8	1	0						
		3	9	.4	31	17	6	3						
		4	19	1.7	37	24	25	15						
		5	30	4.1	41	30	74	47	67	43	63	41	49	32
		6	37	7.3	45	35	149	99	139	94	134	91	120	82
		7	37	9.9	48	39	223	153	209	146	205	143	195	136
		8	30	10.5	51	42	247	174	233	166	230	164	223	159
		9	20	8.8	54	44	216	155	204	148	202	147	198	144
		10	10	5.5	56	47	140	102	133	98	132	97	130	95
		11	4	2 6	59	49	70	51	66	49	66	49	65	49
		12	1	.8	61	50	21	16	20	15	20	15	20	15
			200	51.6			1172	815	1071	759	1052	747	1000	713

ARITH. MEAN DBH= 6.6 , QUADRATIC MEAN DBH= 6.9 , WEIBULL PARAMETERS A= .9 , B= 6.33 , C= 3.06
MEAN CROWN RATIO= 46.8 , LAMBDA= .656
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

30	45	1	1	.0	17	5	0	0						
		2	11	.2	25	11	3	1						
		3	26	1.3	31	20	19	10						
		4	41	3.6	35	27	63	37						
		5	51	7.0	39	33	135	86	124	80	115	75	84	55
		6	53	10.4	43	37	223	150	208	141	201	136	180	123
		7	46	12.3	46	40	283	195	266	185	260	182	247	173
		8	33	11.5	49	43	282	199	267	190	264	188	256	183
		9	20	8 8	51	45	220	158	209	151	207	150	202	147
		10	11	6.0	53	47	154	112	146	108	145	107	143	105
		11	5	3 3	55	49	87	64	83	62	83	61	82	61
		12	2	1.6	57	50	42	31	40	30	40	30	39	30
			300	66.0			1511	1043	1343	947	1315	929	1233	877

ARITH. MEAN DBH= 6.0 , QUADRATIC MEAN DBH= 6.3 , WEIBULL PARAMETERS A= .7 , B= 5 89 , C= 2.63
MEAN CROWN RATIO= 42.6 , LAMBDA= .612
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

30	45	1	6	.0	17	5	0	0						
		2	26	.6	24	13	7	3						
		3	47	2.3	30	22	37	19						
		4	63	5 5	34	29	101	61						
		5	68	9.3	38	34	184	118	169	110	156	103	115	75
		6	63	12 4	41	37	265	178	247	168	238	162	214	146
		7	50	13.4	44	40	308	212	289	201	283	198	269	188
		8	35	12.2	47	43	300	211	283	202	280	199	271	194
		9	22	9.7	49	45	248	177	235	170	233	169	228	165
		10	12	6 5	51	46	165	120	157	115	156	114	153	113
		11	5	3 3	53	48	86	63	81	61	81	60	80	60
		12	2	1 6	55	49	41	31	39	29	39	29	39	29
		13	1	.9	56	50	24	18	23	18	23	17	23	17
			400	77.7			1766	1211	1523	1074	1489	1051	1392	987

ARITH. MEAN DBH= 5.5 , QUADRATIC MEAN DBH= 6.0 , WEIBULL PARAMETERS A= .6 , B= 5.58 , C= 2.33
MEAN CROWN RATIO= 39.7 , LAMBDA= .581
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --: 2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
30	45	1	15	.1	17	5	1	0						
		2	46	1.0	24	14	13	5						
		3	70	3.4	29	23	56	30						
		4	82	7.2	33	29	132	79						
		5	80	10.9	37	34	216	139	199	130	184	121	135	88
		6	69	13.5	40	38	297	199	277	188	267	182	239	164
		7	53	14.2	42	41	333	230	313	219	306	215	291	204
		8	37	12.9	45	43	317	223	299	213	296	211	287	205
		9	23	10.2	47	45	259	186	245	178	243	176	238	173
		10	13	7.1	49	46	184	133	174	128	173	127	171	125
		11	7	4.6	51	47	118	87	112	83	111	83	110	82
		12	3	2.4	53	48	61	45	58	43	57	43	57	43
		13	1	.9	54	49	24	18	23	17	23	17	22	17
		14	1	1.1	56	50	28	21	26	20	26	20	26	20
			500	89.4			2039	1395	1726	1219	1686	1195	1576	1121

ARITH. MEAN DBH= 5.2 , QUADRATIC MEAN DBH= 5.7 , WEIBULL PARAMETERS A= .5 , B= 5 33 , C= 2 09
MEAN CROWN RATIO= 37.4 , LAMBDA- .557
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 IN. O.B.	2 IN. I.B.	3 IN. O.B.	3 IN. I.B.	4 IN. O.B.	4 IN. I.B.
30	45	1	32	2	17	5	1	0						
		2	69	1.5	24	15	20	8						
		3	91	4.5	29	24	75	40						
		4	95	8.3	32	30	156	94						
		5	89	12.1	36	35	246	159	226	148	209	138	153	100
		6	74	14.5	39	38	319	214	297	202	286	195	257	176
		7	56	15.0	41	41	352	243	331	231	324	227	307	216
		8	39	13.6	43	43	334	235	315	225	311	222	302	216
		9	25	11.0	45	45	281	202	267	193	265	192	259	188
		10	15	8.2	47	46	212	154	201	147	200	147	197	145
		11	8	5.3	49	47	139	102	132	98	131	97	130	96
		12	4	3.1	51	48	81	60	77	58	76	57	76	57
		13	2	1.8	52	49	48	36	45	34	45	34	45	34
		14	1	1.1	54	50	28	21	26	20	26	20	26	20
			600	100.2			2292	1568	1917	1356	1873	1329	1752	1248

ARITH. MEAN DBH= 5.0 , QUADRATIC MEAN DBH= 5.5 , WEIBULL PARAMETERS A= .4 , B= 5 13 , C= 1 90
MEAN CROWN RATIO= 35.6 , LAMBDA= .537
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 IN. O.B.	2 IN. I.B.	3 IN. O.B.	3 IN. I.B.	4 IN. O.B.	4 IN. I.B.
30	45	1	87	.5	17	5	3	0						
		2	118	2.6	23	16	35	15						
		3	126	6.2	27	25	107	59						
		4	116	10.1	31	31	195	118						
		5	99	13.5	34	35	278	179	257	167	240	157	[illegible]	109
		6	78	15.3	36	39	336	225	313	213	302	206	270	185
		7	59	15.8	39	41	370	256	349	243	341	239	324	227
		8	42	14.7	41	43	353	253	340	242	335	239	325	233
		9	29	12.9	43	44	320	229	303	219	301	[illegible]	[illegible]	214
		10	13	10.4	44	45	263	191	250	183	248	[illegible]	245	179
		11	12	7.9	46	47	208	153	198	146	197	146	145	144
		12	7	5.5	47	47	144	106	137	102	136	[illegible]	135	101
		13	4	3.7	49	48	93	73	93	70	93	70	92	69
		14	2	2.1	50	49	57	43	54	41	54	41	54	41
		15	1	1.2	51	50	31	24	30	23	30	23	30	23
		16	1	1.4	52	50	35	27	33	25	33	25	33	25
			800	123 6			2840	1950	2356	1675	2310	1649	2166	1551

ARITH. MEAN DBH= 4.6 , QUADRATIC MEAN DBH= 5.4 , WEIBULL PARAMETERS A= [illegible]
MEAN CROWN RATIO= 32.6 , LAMBDA= .506
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

YIELDS GIVEN T_S —

A_P 10

S_I 50

GROWING SEASONS SINCE EST.	AV C+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
10	23	1	1	.0	36	5	0	0						
		2	20	.4	49	13	4	2						
		3	86	4.2	58	18	50	26						
		4	153	13.4	65	21	180	104						
		5	113	15.4	70	23	224	139	201	127	187	119	148	94
		6	26	5.1	74	25	79	52	72	48	70	46	64	42
		7	1	.3	77	26	4	3	4	3	4	3	4	2
			400	38.8			541	326	277	178	261	168	216	138

ARITH. MEAN DBH= 4.1 , QUADRATIC MEAN DBH= 4.2 , WEIBULL PARAMETERS A= .6 , B= 3.81 , C= 4.09
MEAN CROWN RATIO= 65.5 , LAMBDA= .620
CORRESPONDING SITE INDEX FOR BASE AGE 50= 70

10	23	1	3	.0	37	6	0	0						
		2	45	1.0	50	14	10	4						
		3	146	7.2	58	19	88	46						
		4	195	17.0	65	22	236	139						
		5	97	13.2	59	24	198	123	178	113	166	106	131	83
		6	14	2.7	73	26	44	29	40	27	39	26	35	24
			500	41.2			576	340	218	140	205	132	166	107

ARITH. MEAN DBH= 3.8 , QUADRATIC MEAN DBH= 3.9 , WEIBULL PARAMETERS A= .5 , B= 3.57 , C= 3.85
MEAN CROWN RATIO= 63.2 , LAMBDA= .596
CORRESPONDING SITE INDEX FOR BASE AGE 50= 70

10	23	1	9	.0	37	6	0	0						
		2	82	1.8	50	15	20	8						
		3	211	10.4	58	19	128	66						
		4	215	18.8	64	22	260	152						
		5	76	10.4	69	24	155	97	140	88	130	83	102	65
		6	7	1.4	73	26	22	14	20	13	19	13	18	12
			600	42.7			585	337	160	101	149	96	120	77

ARITH. MEAN DBH= 3.5 , QUADRATIC MEAN DBH= 3.6 , WEIBULL PARAMETERS A= .4 , B= 3.37 , C= 3.66
MEAN CROWN RATIO= 61.3 , LAMBDA= .576
CORRESPONDING SITE INDEX FOR BASE AGE 50= 70

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O B	I B.	O B.	I.B.
10	23	1	34	.2	38	6	1	0						
		2	192	4.2	50	15	46	18						
		3	324	15.9	58	19	196	102						
		4	206	18.0	64	22	250	146						
		5	42	5.7	68	24	86	53	77	49	72	46	57	36
		6	2	.4	72	26	6	4	6	4	6	4	5	3
			800	44.4			585	323	83	53	78	50	62	39

ARITH. MEAN DBH= 3.0 , QUADRATIC MEAN DBH= 3.2 , WEIBULL PARAMETERS A= .3 , B= 3 06 , C= 3 36
MEAN CROWN RATIO= 58 4 , LAMBDA= 545
CORRESPONDING SITE INDEX FOR BASE AGE 50= 70

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
10	23	1	87	.5	39	6	3	1						
		2	329	7.2	51	14	73	29						
		3	393	19.3	58	19	238	123						
		4	168	14.7	64	22	204	119						
		5	22	3.0	68	24	45	28	40	26	38	24	30	19
		6	1	.2	71	26	3	2	3	2	3	2	3	2
			1000	44.8			566	302	43	28	41	26	33	21

ARITH. MEAN DBH= 2.7 , QUADRATIC MEAN DBH= 2.9 , WEIBULL PARAMETERS A= .2 , B= 2.81 , C= 3.12
MEAN CROWN RATIO= 56.1 , LAMBDA= .521
CORRESPONDING SITE INDEX FOR BASE AGE 50= 70

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
10	23	1	236	1.3	40	5	8	1						
		2	535	11.7	51	13	114	45						
		3	410	20.1	58	19	248	129						
		4	110	9.6	63	23	137	81						
		5	9	1.2	67	26	19	12	18	11	16	11	13	8
			1300	43.9			526	268	18	11	16	11	13	8

ARITH. MEAN DBH= 2.3 , QUADRATIC MEAN DBH= 2.5 , WEIBULL PARAMETERS A= .1 , B= 2.53 , C= 2.84
MEAN CROWN RATIO= 53.5 , LAMBDA= .492
CORRESPONDING SITE INDEX FOR BASE AGE 50= 70

YIELDS GIVEN T_S —

A_P 20

S_I 50

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                                              ------------------CUBIC FOOT VOLUME-------------------
GROWING                                       ALL TREES      5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET,
SEASONS AV.          STEMS                     GROUND        FOR O.B. TOPS OF --
 SINCE  D+C    DBH     PER   BASAL   CR  AV.   TO TIP        2 INCHES      3 INCHES      4 INCHES
  EST.  HT.           ACRE    AREA       HT.   O.B.  I.B.    O.B.  I.B.    O.B.  I.B.    O.B.  I.B.
----------------------------------------------------------------------------------------------------
  20     43      2       1      .0   29   13      0     0
                 3       9      .4   35   22      7     4
                 4      27     2.4   40   29     41    24
                 5      52     7.1   44   34    141    90     129    84     120    79      88    57
                 6      73    14.3   47   38    314   211     293   199     282   193     253   173

                 7      70    18.7   50   42    448   310     422   295     413   290     392   276
                 8      46    16.1   53   44    394   278     372   266     367   262     355   254
                 9      18     8.0   55   46    202   145     192   139     190   138     186   135
                10       4     2.2   57   48     57    42      54    40      54    40      53    39
                      ----  ------            ----- -----   ----- -----   ----- -----   ----- -----
                       300    69.1             1604  1104    1462  1023    1426  1002    1327   934

    ARITH. MEAN DBH=  6.3 ,     QUADRATIC MEAN DBH=  6.5 ,     WEIBULL PARAMETERS A= 1.0 ,  B=  5.88 ,  C= 3.86
                              MEAN CROWN RATIO= 48.2 ,      LAMBDA=  .551
                          CORRESPONDING SITE INDEX FOR BASE AGE 50= 70



  20     43      2       5      .1   29   15      1     1
                 3      22     1.1   35   24     18    10
                 4      52     4.5   39   31     82    50
                 5      84    11.5   43   36    238   153     219   143     202   133     147    96
                 6      97    19.0   46   40    435   293     407   278     392   268     351   241

                 7      79    21.1   48   42    506   350     476   333     466   327     443   311
                 8      43    15.0   51   45    376   265     355   254     350   250     339   243
                 9      15     6.6   53   47    172   123     163   118     161   117     158   115
                10       3     1.6   55   48     43    31      41    30      40    30      40    29
                      ----  ------            ----- -----   ----- -----   ----- -----   ----- -----
                       400    80.6             1871  1276    1661  1156    1611  1125    1478  1035

    ARITH. MEAN DBH=  5.9 ,     QUADRATIC MEAN DBH=  6.1 ,     WEIBULL PARAMETERS A=  .9 ,  B=  5.56 ,  C= 3.56
                              MEAN CROWN RATIO= 45.3 ,      LAMBDA=  .520
                          CORRESPONDING SITE INDEX FOR BASE AGE 50= 70



  20     43      1       1      .0   21    5      0     0
                 2      11      .2   29   16      3     1
                 3      40     2.0   34   26     35    19
                 4      81     7.1   38   32    131    80
                 5     114    15.5   41   37    330   213     303   199     280   185     204   133

                 6     115    22.8   44   40    521   351     487   332     469   321     419   288
                 7      82    21.9   47   43    536   371     505   354     494   347     469   330
                 8      40    14.0   49   45    356   252     337   241     333   238     322   231
                 9      13     5.7   51   47    149   107     141   102     140   101     137    99
                10       2     1.1   53   48     29    21      27    20      27    20      27    20
                      ----  ------            ----- -----   ----- -----   ----- -----   ----- -----
                       500    90.3             2090  1415    1800  1248    1743  1212    1578  1101

    ARITH. MEAN DBH=  5.5 ,     QUADRATIC MEAN DBH=  5.8 ,     WEIBULL PARAMETERS A=  .8 ,  B=  5.32 ,  C= 3.32
                              MEAN CROWN RATIO= 43.0 ,      LAMBDA=  .496
                          CORRESPONDING SITE INDEX FOR BASE AGE 50= 70
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GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
20	43	1	5	.0	21	6	0	0						
		2	36	.8	28	19	13	5						
		3	90	4.4	33	28	83	45						
		4	143	12.5	36	34	243	148						
		5	162	22.1	40	38	478	310	441	290	407	270	235	193
		6	135	26.5	42	41	618	417	579	395	557	382	498	343
		7	82	21.9	44	43	536	371	505	354	494	347	469	330
		8	35	12.2	46	45	311	220	295	211	291	208	282	202
		9	10	4.4	48	47	117	84	111	80	110	80	108	78
		10	2	1.1	50	48	29	21	28	20	28	[illegible]	27	20
			700	105 9			2428	1621	1959	1350	1887	1307	1674	1166

ARITH. MEAN DBH= 5.0 , QUADRATIC MEAN DBH= 5.3 , WEIBULL PARAMETERS A= 6 , B= 4.95 , C= 2.46
MEAN CROWN RATIO= 39.6 , LAMBDA= .459
CORRESPONDING SITE INDEX FOR BASE AGE 50= 70

20	43	1	15	.1	21	6	1	0						
		2	75	1.6	27	19	26	11						
		3	150	7.4	32	28	138	75						
		4	199	17.4	35	34	358	218						
		5	194	26.5	38	38	573	372	528	348	487	323	353	231
		6	143	28.1	40	41	655	442	613	419	590	405	527	363
		7	79	21.1	42	44	526	365	496	348	486	342	461	325
		8	33	11.5	44	45	294	208	278	199	274	196	266	191
		9	10	4.4	46	47	117	84	111	80	110	80	108	78
		10	2	1.1	48	49	29	21	28	20	28	20	27	20
			900	119.1			2717	1796	2054	1414	1975	1366	1742	1208

ARITH. MEAN DBH= 4.6 , QUADRATIC MEAN DBH= 4.9 , WEIBULL PARAMETERS A= .5 , B= 4.68 , C= 2.70
MEAN CROWN RATIO= 37.0 , LAMBDA= .432
CORRESPONDING SITE INDEX FOR BASE AGE 50= 70

20	43	1	35	.2	21	6	1	0						
		2	126	2.7	27	20	45	20						
		3	211	10.4	31	28	194	106						
		4	246	21.5	34	34	443	269						
		5	215	29.3	37	38	635	412	585	385	540	358	391	256
		6	146	28.7	39	41	669	451	626	428	602	413	538	370
		7	77	20.6	41	44	513	356	484	339	474	333	449	317
		8	32	11.2	43	45	285	201	270	192	266	190	258	185
		9	10	4.4	44	47	117	84	111	80	110	80	108	78
		10	2	1.1	45	48	29	21	28	20	28	20	27	20
			1100	130.0			2931	1920	2104	1444	2020	1394	1771	1226

ARITH. MEAN DBH= 4.3 , QUADRATIC MEAN DBH= 4.7 , WEIBULL PARAMETERS A= .4 , B= 4.46 , C= 2.48
MEAN CROWN RATIO= 35.0 , LAMBDA= .411
CORRESPONDING SITE INDEX FOR BASE AGE 50= 70

YIELDS GIVEN T_S –

A_P 30

S_I 50

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
30	56	3	3	.1	28	19	2	1						
		4	9	.8	32	28	14	8						
		5	18	2.5	35	35	51	32	47	30	44	29	30	20
		6	29	5.7	38	41	133	90	124	85	120	82	107	74
		7	38	10.2	41	46	263	183	248	175	244	172	230	163
		8	38	13.3	43	50	370	263	352	253	347	250	336	242
		9	32	14.1	46	53	415	300	396	289	393	287	384	281
		10	20	10.9	48	56	336	246	321	237	319	236	315	233
		11	9	5.9	50	59	191	141	183	137	182	136	180	135
		12	3	2.4	51	61	75	56	72	54	71	54	71	54
		13	1	.9	53	63	30	23	28	22	28	22	28	22
			200	66.8			1880	1343	1771	1282	1748	1268	1681	1224

ARITH. MEAN DBH= 7.6 , QUADRATIC MEAN DBH= 7.8 , WEIBULL PARAMETERS A= 1.2 , B= 7.03 , C= 3.70
MEAN CROWN RATIO= 42.4 , LAMBDA= .573
CORRESPONDING SITE INDEX FOR BASE AGE 50= 70

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
30	56	2	2	.0	22	12	0	0						
		3	10	.5	27	23	8	4						
		4	23	2.0	30	32	40	24						
		5	39	5.3	33	38	117	75	108	71	101	66	70	46
		6	52	10.2	36	44	252	171	237	163	228	157	203	140
		7	59	15.8	38	48	423	295	400	282	393	277	371	263
		8	50	17.5	41	52	504	359	480	345	473	341	458	331
		9	35	15.5	43	55	469	340	448	327	444	325	435	318
		10	19	10.4	44	57	324	237	310	229	308	228	304	225
		11	8	5.3	46	59	169	126	163	121	162	121	160	120
		12	2	1.6	48	61	52	39	50	37	49	37	49	37
		13	1	.9	49	63	31	23	30	23	30	23	30	22
			300	84.9			2389	1693	2226	1598	2188	1575	2080	1502

ARITH. MEAN DBH= 6.9 , QUADRATIC MEAN DBH= 7.2 , WEIBULL PARAMETERS A= 1.0 , B= 6.59 , C= 3 27
MEAN CROWN RATIO= 38.3 , LAMBDA= .529
CORRESPONDING SITE INDEX FOR BASE AGE 50= 70

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
30	56	2	7	.2	22	14	2	1						
		3	22	1.1	26	25	19	10						
		4	42	3.7	29	34	76	46						
		5	62	8.5	32	40	193	125	179	118	167	110	114	75
		6	72	14.1	34	46	356	241	335	229	321	221	282	195
		7	71	19.0	36	50	527	369	500	353	490	347	463	329
		8	56	19.5	38	53	574	409	547	394	539	389	522	377
		9	37	16.3	40	55	496	359	474	346	470	343	460	337
		10	19	10.4	42	58	329	241	315	233	313	232	309	229
		11	8	5.3	43	60	172	128	165	123	164	123	163	122
		12	3	2.4	45	61	78	58	74	56	74	56	74	55
		13	1	.9	46	63	31	23	30	23	30	23	30	22
			400	101.3			2853	2010	2619	1875	2568	1844	2417	1741

ARITH. MEAN DBH= 6.5 , QUADRATIC MEAN DBH= 6.8 , WEIBULL PARAMETERS A= .9 , B= 6.28 , C= 2.97
MEAN CROWN RATIO= 35.4 , LAMBDA= .498
CORRESPONDING SITE INDEX FOR BASE AGE 50= 70

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
30	56	1	2	.0	16	5	0	0						
		2	15	.3	21	16	5	2						
		3	38	1.9	25	27	34	19						
		4	64	5.6	28	35	118	72						
		5	83	11.3	31	42	268	175	249	164	232	154	150	98
		6	88	17.3	33	47	442	300	416	286	399	276	350	242
		7	80	21.4	35	50	573	400	542	382	530	374	498	353
		8	60	20.9	37	53	615	439	586	422	578	417	559	404
		9	38	16.8	38	56	517	375	495	362	490	359	480	352
		10	20	10.9	40	58	346	254	332	245	330	244	325	241
		11	8	5.3	41	60	172	128	165	123	164	123	163	122
		12	3	2.4	42	61	78	58	74	56	74	56	74	55
		13	1	.9	44	63	31	23	30	23	30	23	30	22
			500	115.0			3199	2245	2889	2063	2827	2026	2629	1889

ARITH. MEAN DBH= 6.1 , QUADRATIC MEAN DBH= 6.5 , WEIBULL PARAMETERS A= 8 . B= 6 03 . C= 2.73
MEAN CROWN RATIO= 33.1 , LAMBDA= .474
CORRESPONDING SITE INDEX FOR BASE AGE 50= 70

30	56	1	4	.0	15	5	0	0						
		2	26	.6	21	17	8	4						
		3	57	2.8	24	28	53	29						
		4	86	7.5	27	37	165	101						
		5	105	14.3	29	43	345	225	321	212	298	199	192	125
		6	102	20.0	31	47	513	348	483	331	463	319	406	281
		7	86	23.0	33	51	626	437	593	418	579	410	545	387
		8	62	21.6	35	54	617	440	587	423	579	417	559	404
		9	39	17.2	37	56	531	385	508	371	503	368	492	361
		10	20	10.9	38	58	346	254	332	245	330	244	325	241
		11	9	5.9	39	60	194	144	186	139	185	138	183	137
		12	3	2.4	40	61	78	58	74	56	74	56	74	55
		13	1	.9	42	63	31	23	30	23	30	23	30	22
			600	127.2			3507	2448	3114	2218	3041	2174	2806	2014

ARITH. MEAN DBH= 5.9 , QUADRATIC MEAN DBH= 6.3 , WEIBULL PARAMETERS A= .7 , B= 5.83 , C= 2.54
MEAN CROWN RATIO= 31.2 , LAMBDA= .454
CORRESPONDING SITE INDEX FOR BASE AGE 50= 70

30	56	1	16	.1	15	5	1	0						
		2	60	1.3	20	18	20	9						
		3	101	5.0	23	29	95	52						
		4	127	11.1	25	37	243	149						
		5	132	18.0	27	43	434	283	403	267	375	250	242	159
		6	120	23.6	29	48	613	417	578	397	554	383	485	337
		7	95	25.4	31	51	692	483	655	462	640	453	602	427
		8	66	23.0	32	54	657	469	625	450	616	444	595	430
		9	41	18.1	34	56	533	386	509	372	504	368	492	360
		10	23	12.5	35	58	381	279	365	270	362	268	356	264
		11	11	7.3	36	59	233	173	224	167	222	166	220	165
		12	5	3.9	37	61	129	97	124	94	124	93	123	92
		13	2	1.8	38	62	61	46	59	45	59	44	58	44
		14	1	1.1	39	63	36	27	34	26	34	26	34	26
			800	152.2			4128	2870	3576	2550	3490	2495	3207	2304

ARITH. MEAN DBH= 5.4 , QUADRATIC MEAN DBH= 5.9 , WEIBULL PARAMETERS A= .5 , B= 5.52 , C= 2.23
MEAN CROWN RATIO= 28.3 , LAMBDA- .423
CORRESPONDING SITE INDEX FOR BASE AGE 50= 70

YIELDS GIVEN T_S —

A_P 10

S_I 60

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                                                          -------------------------CUBIC FOOT VOLUME-------------------------
GROWING                                                   ALL TREES          5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET,
SEASONS  AV.          STEMS                                GROUND            FOR O.B. TOPS OF --
 SINCE   D+C   DBH     PER     BASAL     CR     AV.        TO TIP            2 INCHES              3 INCHES            4 INCHES
  EST.   HT.          ACRE     AREA             HT.      O.B.   I.B.       O.B.   I.B.          O.B.   I.B.         O.B.   I.B.
-------  ------------------------------------------------------------------------------------------------------------------------
  10      28    2        4        .1     45     14          1      0
                3       32       1.6     52     20         20     10
                4      101       8.8     58     24        130     76
                5      153      20.9     62     27        341    215        308    197           288    185          222    142
                6       94      18.5     66     29        321    211        295    196           285    190          258    173
                7       16       4 3     69     31         79     53         73     50            71     49           68     47
                      ----    ------                    -----  -----      -----  -----         -----  -----        -----  -----
                       400      54.1                      892    565        676    443           644    424          548    362

      ARITH. MEAN DBH=  4 9 ,     QUADRATIC MEAN DBH=  5.0 ,     WEIBULL PARAMETERS A=  .9 ,  B=  4.39 ,  C= 4.61
                                           MEAN CROWN RATIO= 61.9 ,       LAMBDA=  .552
                                        CORRESPONDING SITE INDEX FOR BASE AGE 50= 85


  10      28    2       11        .2     45     15          3      1
                3       65       3.2     52     21         42     22
                4      161      14.0     57     25        213    126
                5      180      24.5     62     28        412    260        373    240           348    225          267    171
                6       75      14.7     65     30        263    173        242    162           234    157          211    142
                7        8       2.1     68     31         39     27         36     25            36     25           34     23
                      ----    ---- -                    -----  -----      -----  -----         -----  -----        -----  -----
                       500      58.9                      972    609        651    427           618    407          512    336

      ARITH. MEAN DBH=  4.5 ,     QUADRATIC MEAN DBH=  4.6 ,     WEIBULL PARAMETERS A=  .8 ,  B=  4.14 ,  C= 4 39
                                           MEAN CROWN RATIO= 59.7 ,       LAMBDA=  .528
                                        CORRESPONDING SITE INDEX FOR BASE AGE 50= 85


  10      28    1        1        .0     34      6          0      0
                2       23        .5     44     15          6      2
                3      109       5.4     51     21         70     37
                4      218      19.0     57     25        288    171
                5      190      25.9     61     28        435    275        394    253           367    237          282    181

                6       55      10.8     64     30        193    127        177    119           171    115          155    104
                7        4       1 1     67     31         20     13         18     12            18     12           17     12
                      ----    ------                    -----  -----      -----  -----         -----  -----        -----  -----
                       600      62.7                     1012    625        589    384           556    364          454    297

      ARITH. MEAN DBH=  4.3 ,     QUADRATIC MEAN DBH=  4.4 ,     WEIBULL PARAMETERS A=  .7 ,  B=  3.94 ,  C= 4.18
                                           MEAN CROWN RATIO= 57.8 ,       LAMBDA=  .508
                                        CORRESPONDING SITE INDEX FOR BASE AGE 50= 85
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                                                           -------------------------CUBIC FOOT VOLUME-------------------------
GROWING                                                    ALL TREES           5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET,
SEASONS  AV.            STEMS                               GROUND             FOR O.B. TOPS OF --
 SINCE   D+C     DBH    PER       BASAL     CR     AV.      TO TIP             2 INCHES              3 INCHES             4 INCHES
 EST.    HT.            ACRE      AREA             HT.     O.B.    I.B.       O.B.    I.B.          O.B.    I.B.         O.B.    I.B.
------------------------------------------------------------------------------------------------------------------------------------

  10      28      1        5        .0      34      6        0       0
                  2       65       1.4      44     15       16       6
                  3      223      10.9      51     21      143      75
                  4      312      27.2      56     25      413     244
                  5      167      22.8      60     28      382     241        346     222           323     208          248     159

                  6       26       5.1      63     30       91      60         84      56            81      54           73      49
                  7        1        .3      65     31        5       3          5       3             4       3            4       3
                        ----    ------                    -----   -----      -----   -----         -----   -----        -----   -----
                         800      67.8                     1050     629        435     281           408     265          325     211

      ARITH. MEAN DBH=  3.8 ,     QUADRATIC MEAN DBH=  3.9 ,     WEIBULL PARAMETERS A=  .5 ,  B=  3.63 ,  C= 3.88
                                        MEAN CROWN RATIO= 54.9 ,      LAMBDA=  .477
                                      CORRESPONDING SITE INDEX FOR BASE AGE 50= 85


  10      28      1       15        .1      35      5        1       0
                  2      140       3.1      44     15       34      13
                  3      351      17.2      50     22      242     127
                  4      355      31.0      55     26      483     287
                  5      127      17.3      59     29      298     189        271     174           252     163          193     124
                  6       12       2.4      62     31       43      29         40      27            38      26           35      23
                        ----    ------                    -----   -----      -----   -----         -----   -----        -----   -----
                        1000      71.0                     1101     645        311     201           290     189          228     147

      ARITH. MEAN DBH=  3.5 ,     QUADRATIC MEAN DBH=  3.6 ,     WEIBULL PARAMETERS A=  .4 ,  B=  3.39 ,  C= 3.64
                                        MEAN CROWN RATIO= 52.6 ,      LAMBDA=  .453
                                      CORRESPONDING SITE INDEX FOR BASE AGE 50= 85


  10      28      1       53        .3      35      5        2       0
                  2      301       6.6      44     14       70      28
                  3      521      25.5      50     21      348     182
                  4      345      30.1      54     25      456     270
                  5       76      10.4      57     29      178     113        162     104           151      98          115      74
                  6        4        .8      60     31       14      10         13       9            13       9           12       8
                        ----    ------                    -----   -----      -----   -----         -----   -----        -----   -----
                        1300      73.7                     1068     603        175     113           164     107          127      82

      ARITH. MEAN DBH=  3.1 ,     QUADRATIC MEAN DBH=  3.2 ,     WEIBULL PARAMETERS A=  .3 ,  B=  3.10 ,  C= 3.36
                                        MEAN CROWN RATIO= 49.9 ,      LAMBDA=  .425
                                      CORRESPONDING SITE INDEX FOR BASE AGE 50= 85
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YIELDS GIVEN T_S —

A_P 20

S_I 60

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	ALL TREES GROUND TO TIP I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
20	51	3	3	.1	32	24	2	1						
		4	12	1.0	36	33	20	12						
		5	30	4.1	39	39	90	59	83	55	77	51	56	36
		6	56	11.0	42	44	272	184	255	175	245	169	219	151
		7	75	20.0	44	48	538	375	509	359	499	353	472	334
		8	69	24.1	47	51	683	487	651	468	642	462	622	448
		9	40	17.7	48	54	527	382	504	368	499	365	489	358
		10	13	7.1	50	56	218	160	209	154	207	153	204	151
		11	2	1.3	52	58	40	30	39	29	38	29	38	29
			300	86.5			2390	1690	2250	1608	2207	1582	2100	1507

ARITH. MEAN DBH= 7.1 , QUADRATIC MEAN DBH= 7.3 , WEIBULL PARAMETERS A= 1.2 , B= 6.45 , C= 4.39
MEAN CROWN RATIO= 44.7 , LAMBDA= .483
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
20	51	2	1	.0	27	16	0	0						
		3	8	.4	31	27	7	4						
		4	26	2.3	35	35	48	29						
		5	57	7.8	38	41	179	117	165	109	152	102	109	72
		6	88	17.3	40	45	435	296	409	281	393	271	350	243
		7	99	26.5	42	49	722	505	684	483	671	475	634	450
		8	75	26.2	44	52	756	539	720	518	710	512	687	496
		9	36	15.9	46	54	475	344	453	331	449	328	440	322
		10	9	4.9	48	56	151	111	145	107	144	106	142	105
		11	1	.7	49	58	21	15	20	15	20	15	20	15
			400	101.8			2794	1960	2596	1844	2539	1809	2382	1703

ARITH. MEAN DBH= 6.7 , QUADRATIC MEAN DBH= 6.8 , WEIBULL PARAMETERS A= 1.1 , B= 6.13 , C= 4.08
MEAN CROWN RATIO= 41.7 , LAMBDA= .452
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
20	51	2	3	.1	26	17	1	0						
		3	16	.8	31	28	15	8						
		4	45	3.9	34	36	84	52						
		5	87	11.9	36	42	278	182	257	171	237	158	170	112
		6	118	23.2	39	46	595	405	559	385	537	371	478	332
		7	116	31.0	41	50	861	603	816	577	801	567	756	537
		8	76	26.5	43	52	766	546	729	525	720	518	697	507
		9	31	13.7	44	54	409	296	390	285	387	283	379	[illegible]
		10	7	3.8	46	56	117	86	112	83	112	83	110	1
		11	1	.7	47	58	21	15	20	15	20	15	20	15
			500	115.5			3147	2193	2883	2041	2814	1995	2610	1857

ARITH. MEAN DBH= 6.3 , QUADRATIC MEAN DBH= 6.5 , WEIBULL PARAMETERS A= 1.0 , B= 5.89 , C= 3.84
MEAN CROWN RATIO= 39.4 , LAMBDA= .428
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP		CUBIC FOOT VOLUME: 5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B	I.B	O.B	I.B.
20	51	2	10	.2	26	20	4	2						
		3	43	2.1	29	30	42	23						
		4	97	8.5	32	38	189	116						
		5	150	20.5	34	43	493	322	458	303	426	284	275	180
		6	167	32.8	36	47	857	584	806	556	774	536	689	479
		7	132	35.3	38	50	980	686	929	657	911	645	860	611
		8	71	24.8	40	53	727	519	693	499	684	493	662	478
		9	24	10.6	41	55	322	233	307	225	305	223	298	218
		10	5	2.7	42	56	84	61	80	59	80	59	79	58
		11	1	.7	44	58	21	15	20	15	20	15	20	15
			700	138.1			3719	2561	3293	2314	3200	2255	2883	2039

ARITH. MEAN DBH= 5.8 , QUADRATIC MEAN DBH= 6.0 , WEIBULL PARAMETERS A= 8 , B= 5.52 , C= 3.49
MEAN CROWN RATIO= 36.0 , LAMBDA= .392
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B	3 INCHES I.B	4 INCHES O.B	4 INCHES I.B.
20	51	1	2	.0	20	6	0	0						
		2	26	.6	25	21	10	4						
		3	83	4.1	28	32	84	47						
		4	156	13.6	31	40	316	195						
		5	207	28.2	33	45	704	462	656	436	610	408	391	257
		6	199	39.1	35	49	1034	704	975	671	935	647	818	568
		7	137	36.6	36	52	1052	738	1000	708	979	695	924	658
		8	65	22.7	37	54	677	483	645	465	637	460	616	446
		9	21	9.3	39	56	286	207	273	200	271	198	265	194
		10	4	2.2	40	58	69	51	66	49	66	49	65	48
			900	156.3			4232	2891	3615	2529	3498	2457	3079	2171

ARITH. MEAN DBH= 5.4 , QUADRATIC MEAN DBH= 5.6 , WEIBULL PARAMETERS A= .7 , B= 5.25 , C= 3.22
MEAN CROWN RATIO= 33.5 , LAMBDA= .365
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B	3 INCHES I.B	4 INCHES O.B	4 INCHES I.B.
20	51	1	6	.0	19	6	0	0						
		2	51	1.1	24	21	19	8						
		3	133	6.5	27	32	134	75						
		4	218	19.0	29	40	442	273						
		5	254	34.6	31	45	864	567	805	535	748	500	480	316
		6	218	42.8	33	49	1133	772	1068	735	1024	708	896	622
		7	136	36.3	34	52	1006	704	953	673	931	660	875	622
		8	61	21.3	36	54	635	454	606	437	598	431	578	418
		9	19	8.4	37	56	259	188	247	181	245	179	240	176
		10	4	2.2	38	58	69	51	66	49	66	49	65	48
			1100	172.4			4561	3092	3745	2610	3612	2527	3134	2202

ARITH. MEAN DBH= 5.1 , QUADRATIC MEAN DBH= 5.4 , WEIBULL PARAMETERS A= .6 , B= 5.03 , C= 3.01
MEAN CROWN RATIO= 31.4 , LAMBDA= .343
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

YIELDS GIVEN T_S —

A_P 30

S_I 60

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
30	67	3	1	0	25	22	1	0						
		4	3	.3	29	32	5	3						
		5	9	1.2	32	41	29	19	26	17	25	16	17	11
		6	19	3.7	34	49	99	67	93	64	89	62	78	54
		7	31	8.3	36	54	246	173	234	166	229	163	216	154
		8	40	14.0	38	59	450	323	431	312	425	308	411	298
		9	42	18.6	40	64	644	470	619	455	613	451	601	443
		10	31	16.9	42	67	610	451	588	437	584	435	575	429
		11	17	11.2	43	70	420	313	405	304	403	303	399	300
		12	6	4.7	45	73	182	137	176	134	176	133	174	132
		13	1	.9	46	75	36	28	35	27	35	27	35	27
			200	79.8			2722	1984	2607	1916	2579	1898	2506	1848

ARITH. MEAN DBH= 8.4 , QUADRATIC MEAN DBH= 8.6 , WEIBULL PARAMETERS A= 1.4 , B= 7.61 , C= 4.23
MEAN CROWN RATIO= 38.9 , LAMBDA= .505
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

30	67	3	3	.1	24	25	3	1						
		4	11	1.0	27	36	21	13						
		5	24	3.3	29	45	82	54	76	51	71	47	45	30
		6	41	8.1	32	51	220	150	208	143	199	138	174	121
		7	55	14.7	33	57	439	309	417	296	407	290	382	273
		8	61	21.3	35	61	673	483	643	466	634	460	611	444
		9	51	22.5	37	65	793	579	762	561	755	556	740	546
		10	33	18.0	38	68	653	487	635	472	630	469	621	463
		11	15	9.9	39	71	375	280	362	272	361	271	357	268
		12	5	3.9	41	73	152	114	147	111	146	111	145	110
		13	1	.9	42	75	36	28	35	27	35	27	35	27
			300	103.7			3453	2498	3285	2399	3238	2369	3110	2282

ARITH. MEAN DBH= 7.7 , QUADRATIC MEAN DBH= 8.0 , WEIBULL PARAMETERS A= 1.2 , B= 7.16 , C= 3.80
MEAN CROWN RATIO= 34.7 , LAMBDA= .461
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

30	67	2	2	.0	20	15	1	0						
		3	9	.4	23	28	8	5						
		4	23	2.0	26	39	46	28						
		5	43	5 9	28	47	151	100	141	94	131	88	84	55
		6	64	12.6	30	53	354	243	335	232	321	223	280	195
		7	77	20.6	31	58	623	439	593	421	579	412	543	388
		8	74	25.8	33	63	839	603	803	582	792	575	762	555
		9	56	24.7	34	66	838	611	804	591	796	586	777	573
		10	33	18.0	36	69	667	493	643	479	639	476	629	469
		11	14	9.2	37	71	350	262	338	254	337	253	333	251
		12	4	3.1	38	73	122	92	117	89	117	89	116	88
		13	1	.9	39	75	35	28	35	27	35	27	35	27
			400	123.4			4035	2904	3809	2769	3747	2729	3559	2601

ARITH. MEAN DBH= 7.3 , QUADRATIC MEAN DBH= 7.5 , WEIBULL PARAMETERS A= 1.1 , B= 6 85 , C= 3.49
MEAN CROWN RATIO= 31.8 , LAMBDA= .430
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B	ALL TREES GROUND TO TIP I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
30	67	2	4	.1	19	17	1	1						
		3	17	.8	22	30	16	9						
		4	39	3.4	24	41	81	50						
		5	65	8.9	26	49	236	156	221	148	205	138	122	80
		6	87	17.1	28	55	496	341	470	326	450	313	342	274
		7	95	25.4	30	60	791	559	753	536	735	525	689	494
		8	83	29.0	31	63	941	676	900	653	[illegible]	645	854	622
		9	59	26.1	32	67	894	653	858	632	[illegible]	[illegible]	829	612
		10	32	17.5	33	69	615	455	593	441	589	[illegible]	579	432
		11	14	9.2	34	72	340	254	328	246	326	245	322	243
		12	4	3.1	35	73	117	88	113	86	[illegible]	[illegible]	112	85
		13	1	.9	36	75	36	28	35	27	[illegible]	27	35	27
			500	141.5			4565	3263	4271	3095	[illegible]	3044	3934	2869

ARITH. MEAN DBH= 6.9 , QUADRATIC MEAN DBH= 7.2 , WEIBULL PARAMETERS A= 1.0 , B= 6.60 , C= 3.25
MEAN CROWN RATIO= 29.5 , LAMBDA= .406
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
30	67	2	8	.2	18	18	3	1						
		3	28	1.4	21	32	29	16						
		4	57	5.0	23	42	120	74						
		5	88	12.0	25	50	325	215	304	203	282	190	167	110
		6	108	21.2	27	56	625	430	592	411	567	395	493	346
		7	110	29.4	28	60	916	646	872	621	851	608	798	572
		8	90	31.4	29	64	1034	744	990	718	976	709	939	684
		9	60	26.5	31	67	909	664	873	643	864	637	843	623
		10	32	17.5	32	70	624	461	600	447	596	445	585	438
		11	14	9.2	33	72	340	254	328	246	326	245	322	243
		12	4	3.1	33	74	119	90	115	87	114	87	113	86
		13	1	.9	34	75	35	27	34	26	34	26	34	26
			600	157.8			5078	3622	4708	3402	4610	3342	4295	3128

ARITH. MEAN DBH= 6.6 , QUADRATIC MEAN DBH= 6.9 , WEIBULL PARAMETERS A= .9 , B= 6.41 , C= 3.06
MEAN CROWN RATIO= 27.7 , LAMBDA= .386
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
30	67	1	2	.0	14	5	0	0						
		2	22	.5	17	20	8	3						
		3	58	2.8	20	34	61	34						
		4	98	8.6	22	44	216	134						
		5	131	17.9	23	51	492	325	460	308	426	288	253	167
		6	146	28.7	25	57	857	590	812	565	778	543	677	475
		7	129	34.5	26	61	1089	769	1037	739	1013	723	[illegible]	681
		8	98	34.2	27	65	1141	821	1093	793	1078	784	1037	756
		9	62	27.4	28	67	[illegible]	686	902	664	893	658	[illegible]	643
		10	33	18.0	29	70	643	476	619	461	615	[illegible]	[illegible]	451
		11	14	9.2	29	72	340	254	328	246	[illegible]	[illegible]	322	[illegible]
		12	5	3.9	30	74	149	112	143	109	143	[illegible]	[illegible]	[illegible]
		13	1	.9	31	75	35	27	34	26	34	26	34	26
			800	186.7			5970	4231	5428	3911	[illegible]	[illegible]	[illegible]	[illegible]

ARITH. MEAN DBH= 6.2 , QUADRATIC MEAN DBH= 6.5 , WEIBULL PARAMETERS A= .8 , B= [illegible] , C= [illegible]
MEAN CROWN RATIO= 24.7 , LAMBDA= .355
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

YIELDS GIVEN T_S —

A_P 10

S_I 70

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                                            -------------------------CUBIC FOOT VOLUME-------------------------
GROWING                                      ALL TREES      5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET,
SEASONS  AV.            STEMS                 GROUND        FOR O.B. TOPS OF --
 SINCE  D+C  DBH    PER     BASAL   CR  AV.  TO TIP         2 INCHES           3 INCHES          4 INCHES
 EST.   HT.             ACRE     AREA       HT.    O.B.   I.B.    O.B.   I.B.      O.B.   I.B.      O.B.   I.B.
--------------------------------------------------------------------------------------------------------------
   10    32    2       1       .0   42   14       0      0
               3      11       .5   48   22       8      4
               4      51      4.5   53   27      71     42
               5     123     16.8   57   30     256    188     270    174       251    163       191    123
               6     144     28.3   60   33     544    361     503    338       485    327       437    296

               7      63     16.8   63   35     342    233     318    220       312    216       296    206
               8       7      2.4   66   36      51     35      47     33        47     33        45     32
                    ----   ------             -----  -----   -----  -----     -----  -----     -----  -----
                     400     69.3              1312    863    1138    765      1095    739       969    657

        ARITH. MEAN DBH=  5.5 ,    QUADRATIC MEAN DBH=  5.6 ,    WEIBULL PARAMETERS A= 1.1 ,  B=  4.87 ,  C= 5.06
                                          MEAN CROWN RATIO= 58.9 ,    LAMBDA=  .495
                                        CORRESPONDING SITE INDEX FOR BASE AGE 50= 99


   10    32    2       3       .1   41   15       1      0
               3      25      1.2   48   23      18      9
               4      94      8.2   52   27     131     78
               5     179     24.4   56   31     442    282     403    261       374    244       283    183
               6     154     30.2   59   33     582    386     538    362       519    350       467    316

               7      43     11.5   62   35     233    159     217    150       213    147       202    140
               8       2       .7   64   36      14     10      14     10        13      9        13      9
                    ----   ------             -----  -----   -----  -----     -----  -----     -----  -----
                     500     76.3              1421    924    1172    783      1119    750       965    648

        ARITH. MEAN DBH=  5.2 ,    QUADRATIC MEAN DBH=  5.3 ,    WEIBULL PARAMETERS A= 1.0 ,  B=  4.63 ,  C= 4.82
                                          MEAN CROWN RATIO= 56.7 ,    LAMBDA=  .471
                                        CORRESPONDING SITE INDEX FOR BASE AGE 50= 99


   10    32    2       6       .1   41   16       1      1
               3      46      2.3   47   23      33     17
               4     146     12.7   52   28     209    125
               5     227     31.0   55   31     561    358     511    331       475    309       359    232
               6     146     28.7   58   33     552    366     510    343       492    332       443    300

               7      28      7.5   61   35     152    104     141     98       138     96       132     91
               8       1       .3   63   36       7      5       7      5         7      5         6      5
                    ----   ------             -----  -----   -----  -----     -----  -----     -----  -----
                     600     82.6              1515    976    1169    777      1112    742       940    628

        ARITH. MEAN DBH=  4.9 ,    QUADRATIC MEAN DBH=  5.0 ,    WEIBULL PARAMETERS A=  .9 ,  B=  4.43 ,  C= 4.62
                                          MEAN CROWN RATIO= 54.8 ,    LAMBDA=  .451
                                        CORRESPONDING SITE INDEX FOR BASE AGE 50= 99
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GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	ALL TREES GROUND TO TIP I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
10	32	1	1	.0	32	6	0	0						
		2	20	.4	41	17	5	2						
		3	112	5.5	46	24	82	43						
		4	265	23.1	50	29	400	240						
		5	283	38.6	54	32	716	458	653	425	607	396	457	296
		6	109	21.4	56	34	422	281	391	263	376	255	339	230
		7	10	2.7	59	36	55	38	52	36	51	35	48	34
			800	91.7			1680	1062	1096	724	1034	686	844	560

ARITH. MEAN DBH= 4.5 , QUADRATIC MEAN DBH= 4.6 , WEIBULL PARAMETERS A= .7 , B= 4.11 , C= 4.32
MEAN CROWN RATIO= 51.9 , LAMBDA= .420
CORRESPONDING SITE INDEX FOR BASE AGE 50= 99

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
10	32	1	2	.0	32	5	0	0						
		2	49	1.1	40	16	12	5						
		3	208	10.2	45	23	147	78						
		4	377	32.9	49	28	555	331						
		5	288	39.3	52	32	729	466	665	432	617	403	465	301
		6	72	14.1	55	34	279	185	258	174	249	168	224	152
		7	4	1.1	57	36	22	15	21	14	20	14	19	13
			1000	98.7			1744	1080	944	620	886	585	708	466

ARITH. MEAN DBH= 4.1 , QUADRATIC MEAN DBH= 4.2 , WEIBULL PARAMETERS A= .6 , B= 3.87 , C= 4.08
MEAN CROWN RATIO= 49.6 , LAMBDA= .396
CORRESPONDING SITE INDEX FOR BASE AGE 50= 99

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
10	32	1	10	.1	32	5	0	0						
		2	126	2.7	40	14	29	12						
		3	387	19.0	44	22	267	140						
		4	496	43.3	48	27	712	423						
		5	245	33.4	51	31	605	386	551	357	512	334	388	251
		6	35	6.9	53	34	136	90	125	85	121	82	109	74
		7	1	.3	55	36	6	4	5	4	5	4	5	3
			1300	105.6			1755	1055	681	446	638	420	502	328

ARITH. MEAN DBH= 3.7 , QUADRATIC MEAN DBH= 3.8 , WEIBULL PARAMETERS A= .5 , B= 3.58 , C= 3.80
MEAN CROWN RATIO= 46.9 , LAMBDA= .367
CORRESPONDING SITE INDEX FOR BASE AGE 50= 99

YIELDS GIVEN T_S —

A_P 20

S_I 70

							---CUBIC FOOT VOLUME---							
GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
20	60	3	1	.0	30	26	1	0						
		4	5	.4	33	35	9	6						
		5	16	2.2	36	43	52	34	48	32	44	30	32	21
		6	37	7.3	38	49	197	134	185	128	178	123	158	110
		7	63	16.8	40	54	500	351	476	338	466	331	439	313
		8	77	26.9	42	57	840	602	803	581	792	573	766	556
		9	63	27.8	44	61	925	674	888	651	879	646	860	633
		10	30	16.4	45	63	559	412	537	399	534	396	526	391
		11	7	4.6	46	65	162	120	156	117	155	116	153	115
		12	1	.8	48	67	28	21	27	20	27	20	27	20
			300	103.2			3273	2354	3120	2266	3075	2235	2961	2159

ARITH. MEAN DBH= 7.8 , QUADRATIC MEAN DBH= 7.9 , WEIBULL PARAMETERS A= 1.4 , B= 6.93 , C= 4.83
MEAN CROWN RATIO= 41.7 , LAMBDA= .426
CORRESPONDING SITE INDEX FOR BASE AGE 50= 99

20	60	3	3	.1	29	29	3	2						
		4	12	1.0	32	39	24	15						
		5	34	4.6	34	46	118	77	110	73	102	68	65	43
		6	66	13.0	36	52	369	253	348	242	334	233	296	207
		7	96	25.7	38	56	786	554	749	533	733	523	691	494
		8	98	34.2	40	60	1119	804	1071	776	1057	767	1022	743
		9	63	27.8	41	63	952	694	915	672	906	666	886	653
		10	24	13.1	43	65	460	339	443	329	440	327	433	322
		11	4	2 6	44	67	95	71	92	69	91	68	90	68
			400	122.2			3926	2809	37[illegible]	2694	3653	2652	3483	2530

ARITH. MEAN DBH= 7.3 , QUADRATIC MEAN DBH= 7.5 , WEIBULL PARAMETERS A= 1.3 , B= 6.62 , C= 4.52
MEAN CROWN RATIO= 38.7 , LAMBDA= .395
CORRESPONDING SITE INDEX FOR BASE AGE 50= 99

20	60	2	1	.0	25	19	0	0						
		3	6	.3	28	31	6	3						
		4	23	2.0	31	41	47	29						
		5	56	7.6	33	48	200	132	187	125	174	117	104	68
		6	98	19.2	35	53	542	371	513	355	491	341	428	299
		7	125	33.4	36	57	1039	733	991	705	970	692	914	654
		8	109	38.0	38	60	1245	894	1192	863	1175	853	1136	826
		9	60	26.5	39	63	907	661	871	640	863	634	844	621
		10	19	10.4	40	65	364	269	350	260	348	259	343	255
		11	3	2.0	42	67	71	53	69	51	68	51	68	51
			500	139.5			4421	3145	4173	2999	4089	2947	3837	2774

ARITH. MEAN DBH= 7.0 , QUADRATIC MEAN DBH= 7.1 , WEIBULL PARAMETERS A= 1.2 , B= 6.37 , C= 4.29
MEAN CROWN RATIO= 36.4 , LAMBDA= .371
CORRESPONDING SITE INDEX FOR BASE AGE 50= 99

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME ALL TREES GROUND TO TIP O.B.	ALL TREES GROUND TO TIP I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
20	60	2	3	.1	24	21	1	0						
		3	18	.9	27	34	19	11						
		4	56	4.9	29	43	120	75						
		5	112	15.3	31	49	407	269	380	254	353	237	210	138
		6	162	31.8	32	54	910	624	861	597	825	574	719	503
		7	167	44.6	34	58	1352	951	1286	914	1255	894	1177	842
		8	116	40.5	35	61	1279	918	1223	885	1206	875	1161	844
		9	51	22.5	36	64	782	570	751	552	744	547	730	538
		10	13	7.1	37	66	253	186	243	181	241	180	238	177
		11	2	1.3	38	67	47	35	46	34	45	34	45	34
			700	169.0			5170	3639	4790	3417	4670	3341	4280	3076

ARITH. MEAN DBH= 6.5 , QUADRATIC MEAN DBH= 6.6 , WEIBULL PARAMETERS A= 1.0 , B= 6.00 , C= 3.93
MEAN CROWN RATIO= 33.0 , LAMBDA= .335
CORRESPONDING SITE INDEX FOR BASE AGE 50= 99

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME ALL TREES GROUND TO TIP O.B.	ALL TREES GROUND TO TIP I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
20	60	2	8	.2	23	22	3	1						
		3	40	2.0	25	35	43	24						
		4	101	8.8	27	44	220	137						
		5	175	23.9	29	50	647	427	604	405	560	378	333	219
		6	217	42.6	30	55	1238	850	1171	812	1122	782	977	684
		7	191	51.0	32	58	1546	1088	1470	1045	1436	1023	1347	963
		8	114	39.8	33	61	1257	902	1202	870	1185	859	1141	830
		9	43	19.0	34	64	626	457	601	441	595	437	580	428
		10	10	5.5	35	66	185	137	178	132	177	131	174	129
		11	1	.7	35	67	23	17	22	16	22	16	22	16
			900	193.4			5788	4040	5248	3721	5097	3626	4574	3269

ARITH. MEAN DBH= 6.1 , QUADRATIC MEAN DBH= 6.3 , WEIBULL PARAMETERS A= .9 , B= 5.73 , C= 3.66
MEAN CROWN RATIO= 30.5 , LAMBDA= .307
CORRESPONDING SITE INDEX FOR BASE AGE 50= 99

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME ALL TREES GROUND TO TIP O.B.	ALL TREES GROUND TO TIP I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
20	60	1	1	.0	18	6	0	0						
		2	18	.4	22	22	7	3						
		3	71	3.5	24	35	76	43						
		4	156	13.6	26	44	340	212						
		5	236	32.2	27	50	872	576	815	546	755	509	449	296
		6	259	50.9	29	55	1477	1014	1398	970	1339	933	1166	816
		7	203	54.3	30	58	1643	1157	1563	1111	1526	1087	1431	1024
		8	109	38.0	31	61	1202	863	1149	832	1133	822	1091	793
		9	38	16.8	32	64	554	403	531	390	526	387	513	378
		10	8	4.4	32	66	148	109	142	106	141	105	139	104
		11	1	.7	33	67	23	17	22	16	22	16	22	16
			1100	214.6			6342	4397	5620	3971	5442	3859	4811	3427

ARITH. MEAN DBH= 5.8 , QUADRATIC MEAN DBH= 6.0 , WEIBULL PARAMETERS A= .8 , B= 5.51 , C= 3.45
MEAN CROWN RATIO= 28.4 , LAMBDA= .286
CORRESPONDING SITE INDEX FOR BASE AGE 50= 99

YIELDS GIVEN T_S —

A_P 30

S_I 70

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
30	78	4	1	.1	27	36	2	1						
		5	5	.7	29	47	18	12	16	11	15	10	10	6
		6	11	2.2	31	56	64	44	60	42	58	40	50	35
		7	22	5.9	33	63	191	135	182	130	178	127	166	120
		8	34	11.9	34	69	417	301	400	291	394	287	379	277
		9	45	19.9	36	74	786	577	759	561	751	556	736	546
		10	40	21.8	37	78	904	672	875	654	869	650	855	641
		11	27	17.8	38	82	771	578	747	564	743	562	735	556
		12	12	9.4	40	85	419	317	407	310	405	309	402	306
		13	3	2.8	41	88	126	96	123	94	122	94	121	93
			200	92.4			3698	2733	3569	2657	3535	2635	3454	2580

ARITH. MEAN DBH= 9.0 , QUADRATIC MEAN DBH= 9.2 , WEIBULL PARAMETERS A= 1.6 , B= 8.09 , C= 4.67
MEAN CROWN RATIO= 35.9 , LAMBDA= .448
CORRESPONDING SITE INDEX FOR BASE AGE 50= 99

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
30	78	3	1	.0	22	28	1	1						
		4	5	.4	25	41	10	6						
		5	14	1.9	27	51	53	35	49	33	46	31	27	18
		6	28	5.5	28	59	169	117	160	112	154	107	133	94
		7	46	12.3	30	65	410	290	391	280	381	273	357	257
		8	59	20.6	31	71	741	536	711	519	701	512	674	494
		9	62	27.4	32	75	1036	761	998	738	989	732	963	715
		10	47	25.6	34	79	1019	757	984	737	977	732	961	720
		11	26	17.2	35	82	708	531	685	518	682	515	673	509
		12	10	7.9	36	85	349	264	339	258	338	257	335	255
		13	2	1.8	37	88	84	64	82	63	81	62	81	62
			300	120.7			4580	3362	4399	3258	4349	3221	4204	3124

ARITH. MEAN DBH= 8.4 , QUADRATIC MEAN DBH= 8.6 , WEIBULL PARAMETERS A= 1.4 , B= 7.65 , C= 4.24
MEAN CROWN RATIO= 31.7 , LAMBDA= .404
CORRESPONDING SITE INDEX FOR BASE AGE 50= 99

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
30	78	3	3	.1	21	31	3	2						
		4	12	1.0	23	44	26	16						
		5	27	3.7	25	53	104	69	98	66	91	61	53	35
		6	49	9.6	26	61	304	210	289	202	276	194	240	169
		7	70	18.7	28	67	639	454	612	438	598	429	558	402
		8	81	28.3	29	72	1029	745	989	722	975	712	937	687
		9	73	32.3	30	76	1234	907	1190	880	1178	873	1148	852
		10	50	27.3	31	80	1096	815	1059	793	1052	788	1034	775
		11	25	16.5	32	83	698	517	666	504	663	501	655	495
		12	8	6.3	33	85	269	204	261	199	260	198	257	196
		13	2	1.8	34	88	82	62	79	61	79	61	79	60
			400	145.6			5474	4001	5243	3865	5172	3817	4961	3671

ARITH. MEAN DBH= 7.9 , QUADRATIC MEAN DBH= 8.2 , WEIBULL PARAMETERS A= 1.3 , B= 7.33 , C= 3.93
MEAN CROWN RATIO= 28.8 , LAMBDA= .373
CORRESPONDING SITE INDEX FOR BASE AGE 50= 99

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
30	78	2	1	.0	18	18	0	0						
		3	7	.3	20	33	7	4						
		4	21	1.8	22	46	47	30						
		5	44	6.0	23	55	175	117	164	111	152	103	89	59
		6	72	14.1	25	63	459	318	436	305	417	293	362	256
		7	94	25.1	26	68	870	618	832	596	813	584	759	547
		8	98	34.2	27	73	1260	913	1212	885	1194	873	1148	842
		9	80	35.3	28	77	1368	1006	1319	977	1307	968	1277	948
		10	51	27.8	29	80	1118	831	1081	809	1073	804	1054	791
		11	23	15.2	30	83	633	475	613	463	610	461	602	456
		12	7	5.5	30	86	238	180	231	176	230	175	228	174
		13	2	1.8	31	88	82	62	79	61	79	61	79	60
			----	------			-----	-----	-----	-----	-----	-----	-----	-----
			500	167.3			6257	4554	5967	4383	5875	4322	5598	4133

ARITH. MEAN DBH= 7.6 , QUADRATIC MEAN DBH= 7.8 , WEIBULL PARAMETERS A= 1.2 , B= 7.09 , C= 3.69
MEAN CROWN RATIO= 26.5 , LAMBDA= .349
CORRESPONDING SITE INDEX FOR BASE AGE 50= 99

30	78	2	2	.0	17	19	1	0						
		3	12	.6	19	35	13	7						
		4	34	3.0	21	47	78	49						
		5	64	8.7	22	56	259	172	243	164	224	153	131	87
		6	95	18.7	23	64	614	425	584	408	558	392	484	342
		7	116	31.0	24	69	1086	772	1040	746	1016	730	948	684
		8	111	38.7	25	74	1444	1047	1390	1015	1369	1001	1316	965
		9	85	37.6	26	78	1470	1081	1418	1050	1405	1041	1372	1019
		10	50	27.3	27	81	1108	824	1071	802	1064	797	1045	785
		11	22	14.5	28	83	606	455	586	443	583	441	576	436
		12	7	5.5	28	86	238	180	231	176	230	175	228	174
		13	2	1.8	29	88	82	62	79	61	79	61	79	60
			----	------			-----	-----	-----	-----	-----	-----	-----	-----
			600	187.4			6999	5074	6642	4865	6528	4791	6179	4552

ARITH. MEAN DBH= 7.3 , QUADRATIC MEAN DBH= 7.6 , WEIBULL PARAMETERS A= 1.1 . B= 6 89 . C= 3 50
MEAN CROWN RATIO= 24.7 , LAMBDA= .329
CORRESPONDING SITE INDEX FOR BASE AGE 50= 95

30	78	2	7	.2	16	21	3	1						
		3	29	1.4	17	37	32	18						
		4	66	5.8	19	49	156	98						
		5	107	14.6	20	58	445	297	418	283	386	263	225	150
		6	140	27.5	21	65	916	636	872	611	833	586	722	511
		7	150	40.1	22	70	1422	1012	1362	977	1331	957	1241	897
		8	130	45.4	23	75	1711	1241	1647	1203	1623	1189	1559	1145
		9	91	40.2	23	78	1574	1158	1518	1125	1504	1115	1469	1091
		10	50	27.3	24	81	1108	824	1071	802	1064	797	1045	785
		11	21	13.9	25	84	584	439	566	428	563	426	556	421
		12	7	5.5	25	86	238	180	231	176	230	175	228	174
		13	2	1.8	26	88	82	62	79	61	79	61	79	60
			----	------			-----	-----	-----	-----	-----	-----	-----	-----
			800	223.6			8271	5966	7764	5666	7613	5568	7124	5234

ARITH. MEAN DBH= 6.9 , QUADRATIC MEAN DBH= 7.1 , WEIBULL PARAMETERS A= 1.0 , B= 6.57 , C= 3 19
MEAN CROWN RATIO= 21.7 , LAMBDA= .298
CORRESPONDING SITE INDEX FOR BASE AGE 50= 99

YIELDS GIVEN T_S —

A_P 10

S_I 80

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
10	37	3	4	.2	45	23	3	1						
		4	24	2.1	50	29	36	22						
		5	79	10.8	53	33	205	131	187	122	173	114	130	85
		6	143	28.1	56	36	580	387	538	364	518	352	465	316
		7	118	31.5	59	38	684	470	640	445	628	437	595	415
		8	31	10.8	61	40	245	172	231	164	227	162	220	157
		9	1	.4	63	41	10	7	10	7	10	7	9	7
			400	83.9			1763	1190	1606	1102	1556	1072	1419	980

ARITH. MEAN DBH= 6.1 , QUADRATIC MEAN DBH= 6.2 , WEIBULL PARAMETERS A= 1.2 , B= 5.29 , C= 5.44
MEAN CROWN RATIO= 56.3 , LAMBDA= .445
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
10	37	2	1	.0	39	16	0	0						
		3	9	.4	45	25	7	4						
		4	48	4.2	49	30	74	45						
		5	132	18.0	52	34	350	225	320	209	297	195	222	144
		6	186	36.5	55	37	771	516	716	486	689	469	618	422
		7	107	28.6	57	40	647	446	607	423	595	416	563	394
		8	17	5.9	59	41	137	96	129	92	127	91	124	88
			500	93.7			1986	1332	1772	1210	1708	1171	1527	1048

ARITH. MEAN DBH= 5.8 , QUADRATIC MEAN DBH= 5.9 , WEIBULL PARAMETERS A= 1.1 , B= 5.04 , C= 5.20
MEAN CROWN RATIO= 54.1 , LAMBDA= .421
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
10	37	2	1	.0	39	17	0	0						
		3	18	.9	44	25	13	7						
		4	62	7.2	48	31	130	78						
		5	183	25.8	51	35	513	331	470	307	435	286	324	211
		6	213	41.8	53	37	883	591	820	556	789	537	707	483
		7	88	23.5	56	40	532	367	499	348	489	342	463	324
		8	9	3.1	58	41	73	51	68	49	67	48	65	47
			600	102.3			2144	1425	1857	1260	1780	1213	1559	1065

ARITH. MEAN DBH= 5.5 , QUADRATIC MEAN DBH= 5.6 , WEIBULL PARAMETERS A= 1.0 , B= 4.84 , C= 5.01
MEAN CROWN RATIO= 52.2 , LAMBDA= .401
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I B	O.B.	I.B.
10	37	2	6	.1	38	17	2	1						
		3	51	2.5	43	25	38	20						
		4	174	15.2	46	31	276	166						
		5	297	40.5	49	35	822	530	755	494	699	460	511	333
		6	219	43.0	52	37	908	607	843	572	812	552	727	496
		7	51	13.6	54	40	309	213	289	202	284	198	268	188
		8	2	.7	55	41	16	11	15	11	15	11	15	10
			800	115.6			2371	1548	1902	1279	1810	1221	1521	1027

ARITH. MEAN DBH= 5.0 , QUADRATIC MEAN DBH= 5.1 , WEIBULL PARAMETERS A= .9 , B= 4.53 , C= 4.70
MEAN CROWN RATIO= 49.3 , LAMBDA= .370
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

10	37	2	16	.3	38	16	4	2						
		3	105	5.2	42	25	79	42						
		4	287	25.0	45	30	444	267						
		5	373	50.9	48	34	1009	649	926	604	858	563	629	409
		6	191	37.5	50	37	805	539	750	509	723	492	648	443
		7	27	7.2	52	40	163	113	153	107	150	105	142	100
		8	1	.3	53	41	8	6	8	5	7	5	7	5
			1000	126.5			2512	1618	1837	1225	1738	1165	1426	957

ARITH. MEAN DBH= 4.7 , QUADRATIC MEAN DBH= 4.8 , WEIBULL PARAMETERS A= .8 , B= 4 29 , C= 4.46
MEAN CROWN RATIO= 47.0 , LAMBDA= .346
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

10	37	1	2	.0	31	5	0	0						
		2	47	1.0	37	15	11	4						
		3	226	11.1	41	24	165	87						
		4	464	40.5	44	30	718	432						
		5	419	57.1	46	35	1160	747	1065	697	986	649	721	470
		6	132	25.9	48	39	580	390	542	369	522	357	467	321
		7	10	2.7	50	41	63	43	59	41	58	40	55	39
			1300	138.3			2697	1703	1666	1107	1566	1046	1243	830

ARITH. MEAN DBH= 4.3 , QUADRATIC MEAN DBH= 4.4 , WEIBULL PARAMETERS A= .7 , B= 4.00 , C= 4.19
MEAN CROWN RATIO= 44.3 , LAMBDA= .318
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

YIELDS GIVEN T_S —

A_P 20

S_I 80

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
20	68	4	2	.2	31	39	4	2						
		5	8	1.1	33	48	29	19	27	18	25	17	15	10
		6	23	4.5	35	55	131	90	124	86	119	83	104	73
		7	48	12.8	37	61	423	300	405	289	396	283	373	268
		8	72	25.1	39	65	883	637	847	616	835	608	807	589
		9	77	34.0	40	69	1263	924	1216	897	1204	889	1181	873
		10	50	27.3	41	72	1051	778	1014	756	1008	752	992	741
		11	17	11.2	42	75	447	335	432	326	430	324	425	321
		12	3	2.4	43	77	96	72	93	70	92	70	91	70
			300	118.6			4327	3157	4158	3058	4109	3026	3988	2945

ARITH. MEAN DBH= 8.4 , QUADRATIC MEAN DBH= 8.5 , WEIBULL PARAMETERS A= 1.6 , B= 7.35 , C= 5.21
MEAN CROWN RATIO= 39.1 , LAMBDA= .376
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
20	68	3	1	.0	27	31	1	1						
		4	6	.5	30	42	13	8						
		5	19	2.6	32	51	71	47	67	45	62	42	37	24
		6	45	8.8	33	57	264	182	250	174	240	167	209	146
		7	80	21.4	35	62	685	484	653	466	637	455	597	428
		8	103	36.0	36	66	1280	924	1229	894	1212	883	1171	855
		9	88	38.9	37	70	1462	1071	1409	1040	1395	1030	1367	1011
		10	45	24.5	38	72	946	701	913	681	907	677	893	667
		11	12	7.9	39	75	316	236	305	230	304	229	300	226
		12	1	.8	40	77	32	24	31	23	31	23	30	23
			400	141.5			5070	3678	4857	3553	4788	3506	4604	3380

ARITH. MEAN DBH= 7.9 , QUADRATIC MEAN DBH= 8.1 , WEIBULL PARAMETERS A= 1.5 , B= 7.03 , C= 4.91
MEAN CROWN RATIO= 36.1 , LAMBDA= .345
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
20	68	3	2	.1	26	33	2	1						
		4	11	1.0	29	44	24	15						
		5	34	4.6	30	52	130	86	121	81	112	76	66	44
		6	72	14.1	32	58	429	295	407	283	389	272	338	238
		7	113	30.2	33	63	983	693	936	668	912	653	854	614
		8	128	44.7	34	67	1529	1103	1466	1066	1445	1053	1390	1015
		9	92	40.6	35	70	1448	1060	1392	1027	1379	1018	1344	994
		10	39	21.3	36	73	830	615	801	598	796	595	784	586
		11	8	5.3	37	75	210	157	203	153	202	153	200	151
		12	1	.8	38	77	32	24	31	23	31	23	30	23
			500	162.7			5614	4049	5357	3899	5266	3843	5006	3665

ARITH. MEAN DBH= 7.6 , QUADRATIC MEAN DBH= 7.7 , WEIBULL PARAMETERS A= 1.4 , B= 6.79 , C= 4.67
MEAN CROWN RATIO= 33.9 , LAMBDA= .321
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O B	I B.	O B.	I.B.
20	68	2	1	.0	22	22	0	0						
		3	8	.4	25	37	9	5						
		4	31	2.7	27	47	71	44						
		5	76	10.4	28	55	303	202	284	191	263	178	154	102
		6	134	26.3	29	61	832	575	790	551	756	530	656	462
		7	172	46.0	30	66	1551	1100	1484	1061	1450	1040	1353	975
		8	155	54.1	31	69	1899	1371	1822	1327	1797	1310	1728	1263
		9	89	39.3	32	72	1435	1052	1381	1020	1368	1011	1333	987
		10	29	15.8	33	75	600	445	579	433	575	430	565	423
		11	5	3.3	34	77	129	96	124	94	124	93	122	92
			700	198.3			6829	4890	6464	4677	6333	4592	5911	4304

ARITH. MEAN DBH= 7.0 , QUADRATIC MEAN DBH= 7.2 , WEIBULL PARAMETERS A= 1.2 , B= 6.42 , C= 4.31
MEAN CROWN RATIO= 30.4 , LAMBDA= .285
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

20	68	2	2	.0	21	23	1	0						
		3	18	.9	23	38	21	12						
		4	60	5.2	25	48	140	88						
		5	129	17.6	26	56	522	348	489	330	452	307	265	176
		6	199	39.1	27	62	1252	866	1190	831	1138	799	987	696
		7	220	58.8	28	66	1984	1407	1898	1357	1854	1330	1731	1247
		8	167	58.3	29	70	2071	1497	1989	1449	1960	1430	1885	1379
		9	80	35.3	30	72	1290	946	1242	917	1230	909	1199	888
		10	22	12.0	30	75	456	338	439	328	436	326	429	321
		11	3	2.0	31	77	77	58	75	56	74	56	73	55
			900	229.2			7814	5560	7322	5268	7144	5157	6569	4762

ARITH. MEAN DBH= 6.6 , QUADRATIC MEAN DBH= 6.8 , WEIBULL PARAMETERS A= 1.1 , B= 6.15 , C= 4.04
MEAN CROWN RATIO= 27.9 , LAMBDA= .258
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

20	68	2	6	.1	20	23	2	1						
		3	35	1.7	22	38	40	23						
		4	99	8.6	24	48	230	145						
		5	189	25.8	25	56	764	509	717	484	663	450	388	257
		6	259	50.9	26	62	1630	1127	1548	1082	1481	1039	1285	906
		7	253	67.6	26	66	2282	1618	2182	1561	2132	1529	1990	1434
		8	169	59.0	27	70	2096	1515	2012	1466	1934	1448	1908	1396
		9	71	31.4	28	73	1159	850	1116	824	1105	817	1077	798
		10	17	9.3	28	75	352	261	340	254	337	252	331	248
		11	2	1.3	29	77	51	39	50	38	50	37	49	37
			1100	255.7			8606	6088	7965	5709	7752	5572	7028	5076

ARITH. MEAN DBH= 6.3 , QUADRATIC MEAN DBH= 6.5 , WEIBULL PARAMETERS A= 1.0 , B= 5.93 , C= 3.83
MEAN CROWN RATIO= 25.8 , LAMBDA= .236
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

YIELDS GIVEN T_S —

A_P 30

S_I 80

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
30	89	4	1	.1	25	39	2	1						
		5	2	.3	27	51	8	5	7	5	7	4	4	3
		6	7	1.4	28	61	43	30	41	29	39	28	34	24
		7	15	4.0	30	69	140	100	135	96	131	94	123	89
		8	27	9.4	31	76	360	261	346	253	341	250	328	241
		9	39	17.2	33	81	697	514	673	499	667	495	651	485
		10	43	23.5	34	86	1005	750	973	731	966	726	950	714
		11	37	24.4	35	90	1095	825	1063	805	1057	801	1044	792
		12	21	16.5	36	94	805	611	783	598	780	596	774	591
		13	7	6.5	37	97	322	246	314	241	313	241	311	239
		14	1	1.1	37	100	54	42	53	41	53	41	53	41
			200	104.3			4531	3385	4388	3298	4354	3276	4272	3219

ARITH. MEAN DBH= 9.6 , QUADRATIC MEAN DBH= 9.8 , WEIBULL PARAMETERS A= 1.8 , B= 8.51 , C= 5.05
MEAN CROWN RATIO= 33.3 , LAMBDA= .398
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

30	89	4	2	.2	23	44	4	3						
		5	8	1.1	24	55	32	21	30	20	28	19	16	11
		6	18	3.5	26	65	118	82	112	79	107	75	93	66
		7	34	9.1	27	72	330	235	317	227	309	223	288	209
		8	52	18.2	28	78	708	515	682	499	672	493	646	475
		9	63	27.8	29	83	1151	849	1112	826	1101	818	1076	801
		10	59	32.2	30	88	1408	1051	1364	1025	1354	1018	1331	1001
		11	40	25.4	31	92	1208	910	1173	889	1166	865	1152	874
		12	18	14.1	32	95	659	509	651	497	648	495	643	492
		13	5	4.6	32	98	226	173	220	169	219	169	217	167
		14	1	1.1	33	100	54	41	52	40	52	40	52	40
			300	138.3			5908	4389	5713	4271	5656	4235	5514	4136

ARITH. MEAN DBH= 9.0 , QUADRATIC MEAN DBH= 9.2 , WEIBULL PARAMETERS A= 1.6 , B= 8.06 , C= 4.62
MEAN CROWN RATIO= 29.1 , LAMBDA= .354
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

30	89	3	1	.0	19	34	1	1						
		4	6	.5	21	48	14	9						
		5	16	2.2	23	60	68	46	64	44	59	41	34	23
		6	34	6.7	24	69	234	163	223	157	213	150	184	131
		7	57	15.2	25	76	580	414	557	401	544	393	506	367
		8	78	27.2	26	82	1110	808	1071	785	1055	775	1013	746
		9	83	36.7	27	87	1581	1168	1530	1137	1515	1127	1479	1103
		10	67	36.5	27	91	1648	1231	1598	1201	1586	1193	1558	1174
		11	39	25.7	28	94	1201	905	1166	885	1160	881	1145	870
		12	15	11.8	29	98	574	436	558	427	556	425	551	422
		13	4	3.7	29	100	184	141	179	138	179	137	177	137
			400	166.3			7195	5323	6946	5175	6867	5122	6647	4973

ARITH. MEAN DBH= 8.5 , QUADRATIC MEAN DBH= 8.7 , WEIBULL PARAMETERS A= 1.5 , B= 7.75 , C= 4.31
MEAN CROWN RATIO= 26.2 , LAMBDA= .323
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.3.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I B	4 INCHES O.B.	I.B.
30	89	3	3	.1	18	36	3	2						
		4	11	1.0	20	51	27	17						
		5	28	3.8	21	62	123	83	116	79	107	73	62	41
		6	54	10 6	22	70	376	262	358	252	342	242	296	210
		7	82	21.9	23	77	844	603	810	584	791	572	737	535
		8	101	35.3	24	83	1453	1058	1402	1028	1381	1015	1326	977
		9	97	42.9	25	88	1867	1379	1806	1344	1783	1332	1747	1303
		10	71	38.7	25	91	1746	1305	1693	1273	1681	1265	1651	1244
		11	37	24.4	26	95	1150	858	1117	848	1112	844	1097	834
		12	13	10.2	26	98	497	378	484	370	482	369	478	366
		13	3	2.8	27	100	138	106	134	103	134	103	133	102
			----	------			-----	-----	-----	-----	-----	-----	-----	-----
			500	191.7			8224	6061	7920	5881	78.9	5815	7527	5612

ARITH. MEAN DBH= 8.2 , QUADRATIC MEAN DBH= 8.4 , WEIBULL PARAMETERS A= 1.4 , B= 7.51 , C= 4.08
MEAN CROWN RATIO= 23.9 , LAMBDA= 299
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES GROUND TO TIP O.B.	I.B.	2 INCHES O.B.	I.B.	3 INCHES O.B.	I B	4 INCHES O.B.	I.B.
30	89	2	1	.0	16	20	0	0						
		3	5	.2	17	38	6	3						
		4	19	1.7	19	52	47	30						
		5	43	5.9	20	63	191	129	180	122	166	114	96	64
		6	75	14.7	21	72	535	373	510	359	487	345	421	300
		7	106	28.3	21	78	1103	789	1060	764	1034	748	963	700
		8	120	41.9	22	84	1744	1271	1684	1235	1659	1219	1592	1174
		9	107	47.3	23	88	2059	1522	1992	1482	1973	1469	1927	1438
		10	73	39.8	23	92	1813	1355	1759	1323	1746	1314	1715	1292
		11	36	23.8	24	95	1119	844	1087	825	1082	821	1068	811
		12	12	9.4	24	98	459	349	447	342	445	340	441	338
		13	3	2.8	25	100	138	106	134	103	134	103	133	102
			----	------			-----	-----	-----	-----	-----	-----	-----	-----
			600	215.8			9214	6771	8853	6556	8725	6473	8356	6219

ARITH. MEAN DBH= 7.9 , QUADRATIC MEAN DBH= 8.1 , WEIBULL PARAMETERS A= 1.3 , B= 7.31 , C= 3.88
MEAN CROWN RATIO= 22.1 , LAMBDA= .280
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES GROUND TO TIP O.B.	I.B.	2 INCHES O.B.	I.B.	3 INCHES O.B.	I B	4 INCHES O.B.	I.B.
30	89	2	2	.0	14	22	1	0						
		3	14	.7	16	40	17	9						
		4	40	3.5	17	54	102	65						
		5	79	10.8	18	65	360	243	339	231	313	215	180	120
		6	122	24.0	18	73	880	615	840	592	802	558	693	493
		7	151	40.4	19	79	1589	1137	1527	1101	1490	1078	1388	1009
		8	153	53.4	19	84	2224	1621	2147	1576	2114	1555	2030	1497
		9	120	53.0	20	89	2332	1725	2258	1680	2276	1666	2183	1629
		10	73	39.8	20	92	1813	1355	1759	1323	1746	1314	1715	1292
		11	33	21.8	21	95	1026	774	997	756	991	753	979	744
		12	11	8.6	21	98	421	320	409	313	408	312	404	310
		13	2	1.8	22	100	92	70	90	69	89	69	89	68
			----	------			-----	-----	-----	-----	-----	-----	-----	-----
			800	257.8			10656	7934	10366	7641	10189	7530	9661	7162

ARITH. MEAN DBH= 7.4 , QUADRATIC MEAN DBH= 7.7 , WEIBULL PARAMETERS A= 1.1 , B= 6.99 , C= 3.58
MEAN CROWN RATIO= 19.1 , LAMBDA= .248
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

Appendix 2.

Yield tables given site index, age, and number of trees planted with ideal survival expected.

YIELDS GIVEN T_p WITH IDEAL SURVIVAL —

T_p 500

S_I 40

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
15	27	1	3	.0	29	5	0	0						
		2	26	.6	41	13	6	2						
		3	70	3.4	50	19	44	23						
		4	105	9.2	56	23	131	77						
		5	99	13.5	61	26	214	135	194	124	191	116	140	89
		6	55	10.8	66	28	183	120	168	111	162	108	147	98
		7	17	4.5	69	29	79	53	73	50	72	49	68	47
		8	3	1.0	72	30	19	13	17	12	17	12	17	12
			378	43.1			676	423	452	297	432	285	372	246

ARITH. MEAN DBH= 4.4 , QUADRATIC MEAN DBH= 4.6 , WEIBULL PARAMETERS A= .5 , B= 4.27 , C= 3 26
PERCENT SURVIVAL= 75.6 , MEAN CROWN RATIO= 58.2 , LAMBDA= .642
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

25	40	1	2	.0	19	5	0	0						
		2	17	.4	28	13	4	2						
		3	39	1.9	34	21	29	16						
		4	61	5.3	39	27	88	52						
		5	71	9.7	43	32	183	117	168	109	156	102	115	75
		6	67	13.2	47	36	276	185	257	174	248	168	223	152
		7	51	13.6	50	38	301	207	282	196	275	192	263	183
		8	31	10.8	53	40	245	172	231	164	227	162	220	157
		9	15	6.6	55	42	156	111	147	106	146	105	143	103
		10	6	3.3	58	44	80	58	75	55	75	55	74	54
		11	2	1.3	59	45	32	24	31	23	31	23	30	22
			362	66.1			1394	944	1191	827	1159	807	1068	746

ARITH. MEAN DBH= 5.4 , QUADRATIC MEAN DBH= 5.8 , WEIBULL PARAMETERS A= .6 , B= 5 40 , C= 2.73
PERCENT SURVIVAL= 72.4 , MEAN CROWN RATIO= 45.0 , LAMBDA= .598
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

35	48	1	4	.0	15	5	0	0						
		2	19	.4	22	11	4	2						
		3	35	1.7	27	20	26	13						
		4	46	4.0	31	28	72	43						
		5	53	7.2	35	34	145	93	134	87	126	92	88	57
		6	50	9.8	38	38	215	144	201	136	193	132	173	119
		7	43	11.5	41	42	275	191	259	181	254	178	241	169
		8	33	11.5	44	45	294	208	278	199	274	196	265	191
		9	23	10.2	46	47	269	193	255	185	253	184	248	180
		10	15	8.2	48	49	224	163	213	157	212	156	209	154
		11	8	5.3	50	51	149	110	142	106	141	105	140	104
		12	4	3.1	52	52	87	65	82	62	82	62	81	61
		13	2	1.8	53	53	51	38	49	37	48	37	49	37
		14	1	1.1	55	54	30	27	28	22	28	22	28	22
			336	75.9			1841	1290	1641	1172	1611	1164	1522	1094

ARITH. MEAN DBH= 6.0 , QUADRATIC MEAN DBH= 6.5 , WEIBULL PARAMETERS A= .7 , B= 5 98 , C= 2.23
PERCENT SURVIVAL= 67.2 , MEAN CROWN RATIO= 43.1 , LAMBDA= .534
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

YIELDS GIVEN T_P WITH IDEAL SURVIVAL –

T_P 750

S_I 40

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
15	27	1	13	.1	29	6	0	0						
		2	65	1.4	41	15	16	6						
		3	128	6.3	49	20	83	43						
		4	146	12.7	56	24	188	111						
		5	105	14.3	61	26	227	143	205	131	192	123	149	95
		6	46	9.0	65	28	153	100	140	93	136	90	123	82
		7	12	3.2	68	29	56	38	52	35	51	35	48	73
		8	2	.7	71	30	13	9	12	8	11	8	11	[illegible]
			517	47.8			736	450	409	267	390	256	331	218

ARITH. MEAN DBH= 3.9 , QUADRATIC MEAN DBH= 4.1 , WEIBULL PARAMETERS A= .4 , B= 3.92 , C= 2.93
PERCENT SURVIVAL= 68.9 , MEAN CROWN RATIO= 55.0 , LAMBDA= .608
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
25	40	1	8	.0	20	5	0	0						
		2	35	.8	28	14	10	4						
		3	65	3.2	34	22	51	27						
		4	86	7.5	38	28	127	76						
		5	88	12.0	42	32	227	145	208	135	193	126	143	92
		6	76	14.9	46	36	313	209	291	197	281	191	252	172
		7	53	14.2	48	38	312	215	293	204	287	200	273	191
		8	31	10.8	51	40	245	172	231	164	227	162	220	157
		9	15	6.6	54	42	156	111	147	106	146	105	143	103
		10	6	3.3	56	43	78	57	74	54	73	54	72	53
		11	2	1.3	58	44	32	23	30	22	30	22	30	22
		12	1	.8	59	45	19	14	18	14	18	14	18	13
			466	75.4			1570	1053	1292	896	1255	874	1151	803

ARITH. MEAN DBH= 5.1 , QUADRATIC MEAN DBH= 5.4 , WEIBULL PARAMETERS A= .5 , B= 5.12 , C= 2.46
PERCENT SURVIVAL= 62.1 , MEAN CROWN RATIO= 42.4 , LAMBDA= .571
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
35	48	1	10	.1	15	5	0	0						
		2	32	.7	22	12	8	3						
		3	49	2.4	27	22	38	20						
		4	59	5.1	31	29	95	57						
		5	61	8.3	34	34	168	108	155	101	145	95	101	66
		6	55	10.8	37	38	237	159	221	150	213	145	191	131
		7	46	12.3	40	42	295	204	277	194	272	190	258	181
		8	35	12.2	42	44	305	216	289	205	285	204	277	198
		9	24	10.6	44	47	280	201	266	193	264	192	259	188
		10	16	8.7	46	48	235	171	223	164	222	163	219	161
		11	10	6.6	48	50	183	135	175	129	174	129	172	128
		12	5	3.9	50	51	110	82	105	79	105	78	104	78
		13	3	2.8	52	52	75	57	72	55	71	54	71	54
		14	1	1.1	53	53	29	22	28	21	28	21	28	21
		15	1	1.2	54	54	34	26	32	25	32	25	32	25
			407	86.9			2092	1461	1843	1317	1811	1246	1712	1231

ARITH. MEAN DBH= 5.7 , QUADRATIC MEAN DBH= 6.3 , WEIBULL PARAMETERS A= .6 , B= 5.77 , C= 2.03
PERCENT SURVIVAL= 54.3 , MEAN CROWN RATIO= 36.1 , LAMBDA= .578
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

YIELDS GIVEN T_P WITH IDEAL SURVIVAL —

T_P 1000

S_I 40

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
15	27	1	32	.2	30	7	1	0						
		2	114	2.5	41	16	28	11						
		3	179	8.8	49	21	120	62						
		4	170	14 8	55	24	219	129						
		5	103	14.0	60	27	229	144	207	133	194	125	149	96
		6	39	7.7	64	28	130	85	119	79	115	77	104	70
		7	9	2.4	67	29	42	28	39	26	38	26	36	25
		8	1	.3	70	30	6	4	6	4	6	4	6	4
			647	50.7			775	463	371	242	353	232	295	195

ARITH. MEAN DBH= 3.6 , QUADRATIC MEAN DBH= 3.8 , WEIBULL PARAMETERS A= .3 , B= 3.68 , C= 2.69
PERCENT SURVIVAL= 64.7 , MEAN CROWN RATIO= 52.7 , LAMBDA= .584
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

25	40	1	17	.1	20	5	1	0						
		2	55	1.2	27	15	16	7						
		3	89	4.4	33	24	74	40						
		4	105	9.2	38	29	159	95						
		5	100	13.6	41	33	264	169	242	158	225	147	165	107
		6	80	15.7	44	36	330	220	307	208	296	201	266	181
		7	54	14.4	47	39	325	224	305	212	299	209	284	199
		8	32	11 2	50	40	258	181	243	172	239	170	233	166
		9	16	7.1	52	42	166	119	157	113	155	112	152	110
		10	7	3.8	54	43	91	66	86	63	85	63	84	62
		11	2	1.3	56	44	32	23	30	22	30	22	30	22
		12	1	.8	58	45	19	14	18	14	18	14	18	13
			558	82.8			1735	1158	1388	962	1347	938	1232	860

ARITH. MEAN DBH= 4.8 , QUADRATIC MEAN DBH= 5.2 , WEIBULL PARAMETERS A= .4 , B= 4.92 , C= 2.27
PERCENT SURVIVAL= 55.8 , MEAN CROWN RATIO= 40.6 , LAMBDA= 551
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

35	48	1	18	.1	15	5	1	0						
		2	44	1.0	21	13	12	5						
		3	61	3.0	26	23	49	26						
		4	67	5.8	30	30	110	66						
		5	66	9.0	33	35	186	119	171	112	160	105	112	73
		6	59	11.6	36	39	259	174	242	165	233	159	209	143
		7	48	12.8	39	42	307	213	289	202	283	199	269	189
		8	36	12.6	41	45	320	226	303	217	299	214	290	208
		9	26	11.5	43	47	304	218	289	209	286	208	280	204
		10	17	9.3	45	49	254	185	242	177	240	176	237	174
		11	11	7.3	47	50	201	148	192	142	191	142	189	140
		12	6	4.7	48	51	132	98	126	94	126	94	125	94
		13	4	3.7	50	53	106	80	102	77	101	77	101	76
		14	2	2.1	51	53	58	44	56	43	55	43	55	42
		15	1	1.2	53	54	34	26	32	25	32	25	32	25
			466	95.7			2333	1628	2044	1463	2006	1442	1899	1368

ARITH. MEAN DBH= 5.5 , QUADRATIC MEAN DBH= 6.1 , WEIBULL PARAMETERS A= .5 , B= 5.62 , C= 1.88
PERCENT SURVIVAL= 46.6 , MEAN CROWN RATIO= 34.7 , LAMBDA= .563
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

YIELDS GIVEN T_P WITH IDEAL SURVIVAL –

T_P 1500

S_I 40

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
15	27	1	102	.6	31	7	4	1						
		2	216	4.7	42	16	54	22						
		3	249	12.2	49	22	172	90						
		4	184	16.1	55	25	243	144						
		5	93	12.7	59	27	207	130	187	120	175	113	135	86
		6	32	6.3	63	28	106	70	98	65	94	63	86	57
		7	8	2.1	66	29	37	25	34	24	34	23	32	22
		8	1	.3	68	30	6	4	6	4	6	4	6	4
			885	55.0			829	486	325	213	309	203	259	169

ARITH. MEAN DBH= 3.1 , QUADRATIC MEAN DBH= 3.4 , WEIBULL PARAMETERS A= .1 , B= 3.34 , C= 2.36
PERCENT SURVIVAL= 59.0 , MEAN CROWN RATIO= 49.5 , LAMBDA= .550
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
25	40	1	45	.2	20	5	2	0						
		2	97	2.1	27	17	31	13						
		3	127	6.2	32	25	108	58						
		4	129	11.3	36	30	200	120						
		5	112	15.3	40	34	303	195	278	181	258	169	189	123
		6	85	16.7	43	36	350	234	326	221	314	213	282	192
		7	56	15.0	46	38	330	227	309	215	303	211	288	201
		8	34	11.9	48	40	274	192	258	183	254	181	247	176
		9	18	8.0	50	41	187	133	177	127	175	126	172	124
		10	9	4.9	52	43	117	85	111	81	110	80	108	79
		11	4	2.6	54	43	62	46	59	44	59	43	58	43
		12	1	.8	55	44	19	14	18	13	18	13	17	13
		13	1	.9	57	45	22	17	21	16	21	16	21	16
			718	95.9			2005	1334	1557	1081	1512	1052	1382	967

ARITH. MEAN DBH= 4.4 , QUADRATIC MEAN DBH= 4.9 , WEIBULL PARAMETERS A= .3 , B= 4.65 , C= 2.00
PERCENT SURVIVAL= 47.9 , MEAN CROWN RATIO= 38.0 , LAMBDA= .524
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
35	48	1	37	.2	15	5	1	0						
		2	67	1.5	21	14	19	8						
		3	79	3.9	25	23	64	34						
		4	80	7.0	29	30	132	79						
		5	73	10.0	32	35	205	132	189	123	177	116	124	80
		6	62	12.2	35	39	269	180	252	171	242	165	217	148
		7	50	13.4	37	42	320	222	301	211	295	207	280	197
		8	38	13.3	39	44	332	234	314	224	310	221	300	215
		9	27	11.9	41	46	310	222	294	213	291	211	286	207
		10	19	10.4	43	48	279	203	265	194	263	193	260	191
		11	13	8.6	45	49	234	172	223	165	222	164	219	163
		12	8	6.3	46	50	173	129	165	124	165	123	163	122
		13	5	4.6	48	51	129	96	123	92	122	92	122	92
		14	3	3.2	49	52	90	68	86	65	86	65	85	65
		15	2	2.5	50	53	70	53	67	51	66	51	66	51
		16	1	1.4	52	54	38	29	36	28	36	28	36	28
		17	1	1.6	53	54	42	33	40	31	40	31	39	31
			565	111.7			2707	1894	2355	1692	2315	1667	2198	1590

ARITH. MEAN DBH= 5.2 , QUADRATIC MEAN DBH= 6.0 , WEIBULL PARAMETERS A= .4 , B= 5.41 , C= 1.68
PERCENT SURVIVAL= 37.7 , MEAN CROWN RATIO= 32.8 , LAMBDA= .542
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

YIELDS GIVEN T_P WITH IDEAL SURVIVAL –

T_P 500

S_I 60

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                                                           ------------------------CUBIC FOOT VOLUME------------------------
GROWING                                                    ALL TREES          5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET,
SEASONS  AV.           STEMS                               GROUND             FOR O.B. TOPS OF --
SINCE    D+C   DBH     PER      BASAL     CR     AV.       TO TIP             2 INCHES           3 INCHES             4 INCHES
 EST.    HT.           ACRE     AREA             HT.       O B.    I.B.       O.B.    I B.       O.B     I.B.         O.B.    I.B.
-------------------------------------------------------------------------------------------------------------------------------
  15      41     2        1        .0     33     16           0       0
                 3       12        .6     33     25           9       5
                 4       42       3.7     43     31          67      40
                 5       89      12.1     46     36         252     163        232     152        214     141          156     102
                 6      123      24.2     49     39         541     364        505     344        486     332          436     299

                 7       98      26.2     52     42         618     427        581     406        569     398          538     378
                 8       41      14.3     54     44         351     249        332     237        327     234          317     227
                 9        7       3.1     56     46          79      56         74      54         74      54           72      52
                       ----    ------                     -----   -----      -----   -----      -----   -----        -----   -----
                        413      84.2                      1917    1303       1724    1193       1670    1159         1519    1058

     ARITH. MEAN DBH=  6.0 ,    QUADRATIC MEAN DBH=  6.1 ,    WEIBULL PARAMETERS A= 1.0 ,  B=  5.44 ,  C= 4.33
                   PERCENT SURVIVAL= 82.6 ,        MEAN CROWN RATIO= 49.4 ,       LAMBDA=  .482
                                   CORRESPONDING SITE INDEX FOR BASE AGE 50= 85



  25      60     2        1        .0     23     15           0       0
                 3        6        .3     27     27           5       3
                 4       20       1.7     30     37          38      23
                 5       42       5.7     32     44         140      92        131      87        122      81           78      51
                 6       67      13.2     34     50         354     241        334     230        320     222          280     195

                 7       83      22.2     36     54         658     463        627     445        613     436          578     413
                 8       76      26.5     38     58         842     604        805     583        794     575          768     558
                 9       52      23.0     40     61         764     556        733     538        726     533          710     522
                10       24      13.1     41     63         447     329        430     319        427     317          421     313
                11        7       4.6     42     66         164     122        158     118        157     118          155     117
                12        1        .8     44     67          28      21         27      20         27      20           27      20
                       ----    ------                     -----   -----      -----   -----      -----   -----        -----   -----
                        379     111.1                      3440    2454       3245    2340       3186    2302         3017    2189

     ARITH. MEAN DBH=  7.1 ,    QUADRATIC MEAN DBH=  7.3 ,    WE'BULL PARAMETERS A= 1.1 ,  B=  6.62 ,  C= 3.84
                   PERCENT SURVIVAL= 75.8 ,        MEAN CROWN RATIO= 36.6 ,       LAMBDA=  .442
                                   CORRESPONDING SITE INDEX FOR BASE AGE 50= 85



  35      73     2        1        .0     18     13           0       0
                 3        5        .2     21     26           4       2
                 4       14       1.2     24     37          27      16
                 5       28       3.8     26     47          99      65         92      61         85      57           54      36
                 6       43       8.4     28     54         242     166        229     158        219     152          191     133

                 7       55      14.7     29     60         458     323        436     310        426     304          399     286
                 8       57      19.9     31     65         664     478        636     461        627     456          603     440
                 9       50      22.1     32     69         777     568        747     551        740     546          721     533
                10       36      19.6     34     72         719     533        693     517        688     514          677     506
                11       20      13.2     35     75         503     376        486     366        483     364          477     360

                12        9       7.1     36     77         287     217        278     211        277     210          274     209
                13        3       2.8     37     80         116      88        112      86        112      85          111      85
                14        1       1.1     38     82          45      35         44      34         44      34           44      34
                       ----    ------                     -----   -----      -----   -----      -----   -----        -----   -----
                        322     114.2                      3941    2867       3753    2755       3701    2722         3551    2622

     ARITH. MEAN DBH=  7.7 ,    QUADRATIC MEAN DBH=  8.0 ,    WEIBULL PARAMETERS A= 1.2 ,  B=  7.29 ,  C= 3.44
                   PERCENT SURVIVAL= 64.4 ,        MEAN CROWN RATIO= 30.6 ,       LAMBDA=  .452
                                   CORRESPONDING SITE INDEX FOR BASE AGE 50= 85
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YIELDS GIVEN T_P WITH IDEAL SURVIVAL –

T_P 750

S_I 60

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B	3 INCHES O B	I B	4 INCHES O.B.	I.B.
15	41	2	6	.1	33	18	2	1						
		3	33	1.6	38	27	26	14						
		4	90	7.9	42	33	149	91						
		5	151	20.6	45	37	437	283	402	264	371	246	270	177
		6	158	31.0	48	40	703	478	663	452	638	437	571	392
		7	95	25.4	50	42	609	421	573	401	561	393	532	374
		8	28	9.8	52	44	240	169	227	162	223	160	216	155
		9	4	1.8	54	46	45	32	43	31	42	31	41	30
			565	98.1			2217	1489	1908	1310	1835	1267	1630	1128

ARITH. MEAN DBH= 5.5 , QUADRATIC MEAN DBH= 5.6 , WEIBULL PARAMETERS A= .9 , B= 5.10 , C= 4.00
PERCENT SURVIVAL= 75.3 , MEAN CROWN RATIO= 46.2 , LAMBDA= .448
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B	3 INCHES O B	I B	4 INCHES O.B.	I.B.
25	60	2	3	.1	22	17	1	0						
		3	14	.7	26	30	14	7						
		4	37	3.2	28	39	74	45						
		5	69	9.4	31	46	239	157	223	148	207	138	132	87
		6	96	18.8	33	51	515	352	486	336	466	323	407	284
		7	104	27.8	34	55	805	565	765	542	747	531	701	500
		8	85	29.7	36	59	956	687	915	662	902	654	873	634
		9	51	22.5	37	61	749	545	719	527	712	523	696	512
		10	22	12.0	39	64	416	306	400	297	397	295	391	291
		11	6	4.0	40	66	141	105	135	101	135	101	133	100
		12	1	.8	41	67	28	21	27	20	27	20	27	20
			488	129.0			3938	2790	3670	2633	3593	2585	3360	2428

ARITH. MEAN DBH= 6.7 , QUADRATIC MEAN DBH= 7.0 , WEIBULL PARAMETERS A= 1.0 , B= 6.34 , C= 3.57
PERCENT SURVIVAL= 65.1 , MEAN CROWN RATIO= 34.0 , LAMBDA= .415
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B	3 INCHES O B	I B	4 INCHES O.B.	I.B.
35	73	2	2	.0	17	14	1	0						
		3	10	.5	20	28	9	5						
		4	23	2.0	23	39	46	28						
		5	41	5.6	25	48	147	97	137	91	127	85	76	50
		6	57	11.2	26	55	325	223	308	213	295	205	257	180
		7	65	17.4	28	61	549	387	523	373	510	365	478	343
		8	67	23.4	29	65	780	562	747	542	737	536	709	517
		9	55	24.3	31	69	855	625	822	606	814	601	793	586
		10	37	20.2	32	73	748	554	721	538	716	535	704	526
		11	20	13.2	33	75	503	376	486	366	483	364	477	360
		12	9	7.1	34	78	280	211	271	206	270	205	267	203
		13	3	2.8	35	80	113	86	109	83	109	83	108	83
		14	1	1.1	36	82	45	35	44	34	44	34	44	34
			390	128.7			4401	3189	4168	3052	4165	3013	3913	2882

ARITH. MEAN DBH= 7.4 , QUADRATIC MEAN DBH= 7.8 , WEIBULL PARAMETERS A= 1.1 , B= 7.08 , C= 3.23
PERCENT SURVIVAL= 52.0 , MEAN CROWN RATIO= 28.7 , LAMBDA= .432
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

YIELDS GIVEN T_P WITH IDEAL SURVIVAL –

T_P 1000

S_I 60

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
15	41	1	1	.0	25	6	0	0						
		2	14	.3	32	19	5	2						
		3	63	3.1	37	27	50	27						
		4	144	12.6	41	33	239	145						
		5	202	27.5	44	37	584	378	538	353	497	328	361	236
		6	175	34.4	46	40	786	529	734	501	707	484	632	434
		7	85	22.7	48	42	545	377	513	359	502	352	476	335
		8	20	7.0	50	44	175	123	165	118	163	116	158	113
		9	2	.9	52	46	22	16	21	15	21	15	21	15
			----	------			-----	-----	-----	-----	-----	-----	-----	-----
			706	108.5			2406	1597	1971	1346	1890	1295	1648	1133

ARITH. MEAN DBH= 5.1 , QUADRATIC MEAN DBH= 5.3 , WEIBULL PARAMETERS A= .8 , B= 4.85 , C= 3.76
PERCENT SURVIVAL= 70.6 , MEAN CROWN RATIO= 43.9 , LAMBDA= .424
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

25	60	2	6	.1	22	19	2	1						
		3	24	1.2	25	31	24	13						
		4	56	4.9	28	40	114	70						
		5	94	12.8	30	47	331	218	309	206	286	192	183	121
		6	119	23.4	31	52	649	444	613	423	587	408	512	357
		7	118	31.5	33	56	928	652	881	625	861	612	808	577
		8	90	31.4	35	59	965	691	921	666	907	657	875	635
		9	50	22.1	36	62	745	543	715	525	708	521	693	510
		10	20	10.9	37	64	376	279	363	270	361	268	356	265
		11	6	4.0	38	66	141	105	135	101	135	101	133	100
		12	1	.8	39	67	28	21	27	20	27	20	27	20
			----	------			-----	-----	-----	-----	-----	-----	-----	-----
			584	143.1			4305	3037	3964	2836	3872	2779	3587	2585

ARITH. MEAN DBH= 6.4 , QUADRATIC MEAN DBH= 6.7 , WEIBULL PARAMETERS A= .9 , B= 6.14 , C= 3.38
PERCENT SURVIVAL= 58.4 , MEAN CROWN RATIO= 32.2 , LAMBDA= .396
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

35	73	2	4	.1	17	15	1	0						
		3	14	.7	20	29	13	7						
		4	32	2.8	22	40	65	40						
		5	52	7.1	24	49	189	125	177	118	164	110	98	64
		6	69	13.5	26	56	399	274	378	263	362	253	315	221
		7	76	20.3	27	62	650	460	621	443	605	433	567	407
		8	73	25.5	28	66	861	620	825	599	814	592	783	571
		9	57	25.2	29	70	897	657	863	636	855	631	833	616
		10	37	20.2	31	73	748	554	721	538	716	535	704	526
		11	20	13.2	32	76	509	381	492	370	489	369	483	365
		12	9	7.1	33	78	280	211	271	206	270	205	267	203
		13	3	2.8	33	80	113	86	109	83	109	83	108	83
		14	1	1.1	34	82	45	34	43	33	43	33	43	33
			----	------			-----	-----	-----	-----	-----	-----	-----	-----
			447	139.5			4770	3449	4300	3289	4427	3244	4201	3089

ARITH. MEAN DBH= 7.2 , QUADRATIC MEAN DBH= 7.6 , WEIBULL PARAMETERS A= 1.0 , B= 6.94 , C= 3.09
PERCENT SURVIVAL= 44.7 , MEAN CROWN RATIO= 27.3 , LAMBDA= .417
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

YIELDS GIVEN T_P WITH IDEAL SURVIVAL —

T_P 1500

S_I 60

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	ALL TREES GROUND TO TIP I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
15	41	1	4	.0	25	6	0	0						
		2	45	1.0	31	19	16	7						
		3	142	7.0	36	28	114	62						
		4	249	21.7	39	33	413	251						
		5	269	36.7	42	37	778	503	716	470	662	437	481	314
		6	178	35.0	44	40	799	538	747	510	719	492	643	442
		7	66	17.6	46	42	423	293	398	278	390	273	370	260
		8	12	4.2	48	44	105	74	99	71	98	70	95	68
		9	1	.4	49	46	11	8	11	8	11	8	11	8
			966	123.6			2659	1736	1971	1337	1880	1280	1600	1092

ARITH. MEAN DBH= 4.7 , QUADRATIC MEAN DBH= 4.8 , WEIBULL PARAMETERS A= .6 , B= 4.51 , C= 3.43
PERCENT SURVIVAL= 64.4 , MEAN CROWN RATIO= 40.7 , LAMBDA= .390
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
25	60	1	1	.0	17	5	0	0						
		2	15	.3	21	20	5	2						
		3	48	2.4	24	33	50	28						
		4	95	8.3	26	42	200	124						
		5	137	18.7	28	48	490	323	458	305	425	285	254	167
		6	154	30.2	30	53	852	584	806	558	772	537	673	470
		7	136	36.3	31	57	1085	763	1031	732	1007	717	945	675
		8	93	32.5	32	60	1012	725	966	699	951	689	918	667
		9	49	21.6	33	62	695	506	665	488	659	484	643	473
		10	19	10.4	34	64	343	252	329	244	327	243	321	239
		11	5	3.3	35	66	112	84	108	81	108	81	106	80
		12	1	.8	36	67	28	21	27	20	27	20	27	20
			753	164.8			4872	3412	4390	3127	4276	3056	3887	2791

ARITH. MEAN DBH= 6.1 , QUADRATIC MEAN DBH= 6.3 , WEIBULL PARAMETERS A= .8 , B= 5.87 , C= 3.11
PERCENT SURVIVAL= 50.2 , MEAN CROWN RATIO= 29.6 , LAMBDA= .368
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
35	73	2	8	.2	16	17	3	1						
		3	24	1.2	19	31	24	13						
		4	48	4.2	21	42	101	63						
		5	71	9.7	23	51	266	176	249	167	231	156	137	90
		6	87	17.1	24	57	511	352	484	336	463	324	403	283
		7	90	24.1	25	63	780	552	745	532	726	520	681	489
		8	80	27.9	27	67	956	689	916	666	903	658	869	635
		9	61	26.9	28	70	960	703	923	681	915	675	891	659
		10	39	21.3	29	73	789	584	760	567	755	564	742	555
		11	21	13.9	30	76	534	400	516	389	514	387	507	383
		12	9	7.1	30	78	280	211	271	206	270	205	267	203
		13	3	2.8	31	80	113	86	109	83	109	83	108	83
		14	1	1.1	32	82	45	34	43	33	43	33	43	33
			542	157.3			5362	3864	5016	3660	4929	3605	4648	3413

ARITH. MEAN DBH= 6.9 , QUADRATIC MEAN DBH= 7.3 , WEIBULL PARAMETERS A= .9 , B= 6.73 , C= 2.88
PERCENT SURVIVAL= 36.1 , MEAN CROWN RATIO= 25.3 , LAMBDA= 396
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

YIELDS GIVEN T_P WITH IDEAL SURVIVAL –

T_P 500

S_I 80

							CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
15	54	3	2	.1	34	29	2	1						
		4	10	.9	37	37	18	11						
		5	34	4.6	39	43	111	73	103	68	94	63	67	45
		6	78	15.3	41	48	407	278	384	265	368	255	327	228
		7	121	32.3	43	52	929	652	883	625	865	614	816	581
		8	114	39.8	45	55	1206	862	1151	830	1135	820	1099	796
		9	54	23.9	46	57	747	542	715	523	708	519	693	508
		10	10	5.5	48	59	176	129	169	125	167	124	165	122
		11	1	.7	49	61	22	16	21	16	21	16	21	15
			424	123.0			3618	2564	3426	2452	3358	2411	3188	2295

ARITH. MEAN DBH= 7.2 , QUADRATIC MEAN DBH= 7.3 , WEIBULL PARAMETERS A= 1.4 , B= 6.31 , C= 5.13
PERCENT SURVIVAL= 84.8 , MEAN CROWN RATIO= 43.5 , LAMBDA= .372
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
25	80	3	1	.0	23	31	1	1						
		4	3	.3	26	44	7	4						
		5	12	1.6	27	54	47	31	44	30	41	28	24	16
		6	28	5.5	29	62	176	122	167	117	160	112	139	98
		7	52	13.9	30	68	481	342	460	330	450	323	420	303
		8	74	25.8	31	74	963	698	926	676	913	668	877	644
		9	80	35.3	32	78	1384	1018	1335	989	1322	980	1292	959
		10	62	33.8	33	82	1389	1034	1344	1007	1334	1000	1311	984
		11	30	19.8	34	85	844	634	817	618	813	615	803	608
		12	9	6.3	35	87	275	208	266	203	265	202	263	201
		13	1	.9	36	90	43	33	42	32	42	32	41	32
			351	143.3			5610	4125	5401	4002	5340	3960	5170	3845

ARITH. MEAN DBH= 8.5 , QUADRATIC MEAN DBH= 8.7 , WEIBULL PARAMETERS A= 1.5 , B= 7.60 , C= 4.74
PERCENT SURVIVAL= 70.2 , MEAN CROWN RATIO= 31.8 , LAMBDA= .344
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
35	97	4	2	.2	21	44	4	3						
		5	5	.7	22	56	20	13	19	13	18	12	10	7
		6	13	2.6	24	67	87	61	83	58	79	56	69	49
		7	24	6.4	25	75	241	172	232	167	226	163	211	153
		8	38	13.3	26	83	547	398	527	387	519	382	499	368
		9	49	21.6	27	89	952	704	922	686	913	680	891	665
		10	51	27.8	28	94	1291	966	1253	943	1244	937	1222	922
		11	40	26.4	29	98	1279	966	1244	945	1237	940	1221	929
		12	23	18.1	30	102	913	695	889	680	885	678	878	673
		13	9	8.3	30	106	437	335	426	328	424	327	422	325
		14	2	2.1	31	109	116	90	113	88	113	88	112	87
			256	127.4			5887	4403	5708	4295	5653	4263	5535	4178

ARITH. MEAN DBH= 9.4 , QUADRATIC MEAN DBH= 9.6 , WEIBULL PARAMETERS A= 1.7 , B= 8.45 , C= 4.51
PERCENT SURVIVAL= 51.2 , MEAN CROWN RATIO= 27.4 , LAMBDA= .371
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

YIELDS GIVEN T_P WITH IDEAL SURVIVAL —

T_P 750

S_I 80

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
15	54	3	5	.2	33	32	5	3						
		4	26	2.3	35	40	53	33						
		5	75	10.2	37	46	258	170	239	160	220	148	156	104
		6	141	27.7	39	50	762	522	719	498	690	480	612	427
		7	171	45.7	41	54	1357	954	1291	916	1264	899	1192	851
		8	118	41.2	42	57	1288	923	1231	890	1214	879	1174	852
		9	39	17.2	43	59	556	404	533	391	528	387	516	379
		10	5	2.7	45	61	91	67	87	64	86	64	85	63
			580	147.3			4370	3076	4100	2919	4002	2857	3735	2676

ARITH. MEAN DBH= 6.7 , QUADRATIC MEAN DBH= 6.8 , WEIBULL PARAMETERS A= 1.2 , B= 5.97 , C= 4.79
PERCENT SURVIVAL= 77.3 , MEAN CROWN RATIO= 40.3 , LAMBDA= .339
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
25	80	3	2	.1	22	34	2	1						
		4	8	.7	24	47	18	11						
		5	23	3.1	26	56	93	62	87	59	81	55	47	31
		6	48	9.4	27	64	310	215	295	206	282	198	244	173
		7	80	21.4	28	70	758	540	727	521	710	511	662	478
		8	100	34.9	29	75	1317	955	1267	926	1248	914	1200	881
		9	96	42.4	30	79	1679	1236	1620	1201	1605	1190	1568	1165
		10	63	34.4	31	82	1412	1051	1365	1023	1355	1016	1332	1000
		11	26	17.2	32	85	731	550	708	536	705	533	696	527
		12	6	4.7	32	88	208	158	202	154	201	153	199	152
		13	1	.9	33	90	42	32	41	31	40	31	40	31
			453	169.2			6570	4811	6312	4657	6227	4601	5988	4438

ARITH. MEAN DBH= 8.1 , QUADRATIC MEAN DBH= 8.3 , WEIBULL PARAMETERS A= 1.4 , B= 7.32 , C= 4.48
PERCENT SURVIVAL= 60.4 , MEAN CROWN RATIO= 29.2 , LAMBDA= .316
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
35	97	3	1	.0	18	31	1	1						
		4	3	.3	20	46	7	4						
		5	9	1.2	21	59	38	25	36	24	33	22	19	13
		6	20	3.9	22	69	138	96	131	92	125	88	108	77
		7	35	9.4	23	77	360	257	346	249	338	244	315	228
		8	50	17.5	24	84	727	530	702	515	691	508	663	489
		9	60	26.5	25	90	1178	871	1141	849	1129	842	1103	823
		10	57	31.1	26	95	1457	1090	1414	1065	1404	1058	1379	1040
		11	42	27.7	27	99	1355	1024	1318	1001	1311	997	1294	985
		12	23	18.1	28	103	921	701	897	687	893	684	886	679
		13	8	7.4	28	106	388	298	378	292	377	291	375	289
		14	2	2.1	29	109	116	90	113	88	113	88	112	87
			310	145.2			6686	4987	6476	4862	6414	4822	6254	4710

ARITH. MEAN DBH= 9.1 , QUADRATIC MEAN DBH= 9.3 , WEIBULL PARAMETERS A= 1.6 , B= 8.24 , C= 4.30
PERCENT SURVIVAL= 41.3 , MEAN CROWN RATIO= 25.4 , LAMBDA= .350
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

YIELDS GIVEN T_p WITH IDEAL SURVIVAL –

T_p 1000

S_I 80

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
15	54	2	1	.0	28	21	0	0						
		3	12	.6	31	33	12	7						
		4	50	4.4	34	41	103	64						
		5	124	16.9	36	46	427	281	396	265	364	245	258	171
		6	199	39.1	38	51	1093	750	1032	716	990	689	878	614
		7	200	53.5	39	54	1587	1116	1510	1072	1478	1052	1394	995
		8	110	38.4	40	57	1201	860	1147	829	1132	819	1095	794
		9	27	11.9	41	59	385	280	369	270	365	268	357	263
		10	2	1.1	42	61	36	27	35	26	35	26	34	25
			725	165.8			4844	3385	4489	3178	4364	3099	4016	2862

ARITH. MEAN DBH= 6.3 , QUADRATIC MEAN DBH= 6.5 , WEIBULL PARAMETERS A= 1.1 , B= 5.73 , C= 4.56
PERCENT SURVIVAL= 72.5 , MEAN CROWN RATIO= 38.0 , LAMBDA= .314
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

25	80	3	3	.1	21	36	3	2						
		4	13	1.1	23	48	30	19						
		5	35	4.8	24	58	146	97	137	92	126	86	74	49
		6	69	13.5	26	65	452	313	430	301	411	289	356	252
		7	105	28.1	27	71	1008	717	956	693	943	679	880	636
		8	122	42.6	28	76	1625	1179	1554	1143	1541	1128	1481	1088
		9	104	45.9	28	79	1819	1339	1755	1301	1739	1290	1699	1262
		10	62	33.8	29	83	1404	1046	1359	1018	1349	1012	1325	996
		11	23	15.2	30	85	647	486	627	474	623	472	616	466
		12	5	3.9	30	88	173	131	168	128	168	128	166	127
		13	1	.9	31	90	42	32	41	31	40	31	40	31
			542	190.0			7349	5361	7047	5181	6940	5115	6637	4907

ARITH. MEAN DBH= 7.8 , QUADRATIC MEAN DBH= 8.0 , WEIBULL PARAMETERS A= 1.3 , B= 7.13 , C= 4.29
PERCENT SURVIVAL= 54.2 , MEAN CROWN RATIO= 27.4 , LAMBDA= 297
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

35	97	3	1	.0	17	32	1	1						
		4	5	.4	19	48	12	7						
		5	13	1.8	20	60	56	37	52	-	48	33	28	19
		6	26	5.1	21	70	181	126	173	121	165	117	143	101
		7	44	11.8	22	78	458	327	440	317	429	310	400	290
		8	61	21.3	23	85	896	653	865	635	852	627	818	604
		9	68	30.0	24	90	1335	987	1293	962	1280	954	1250	933
		10	62	33.8	25	95	1585	1186	1539	1158	1527	1151	1500	1132
		11	43	28.4	26	99	1388	1048	1350	1025	1342	1020	1325	1008
		12	22	17.3	26	103	881	671	858	657	854	655	847	649
		13	8	7.4	27	106	388	298	378	292	377	291	375	289
		14	2	2.1	27	109	116	90	113	88	113	88	112	87
			355	159.4			7297	5431	7061	5290	6987	5246	6798	5112

ARITH. MEAN DBH= 8.9 , QUADRATIC MEAN DBH= 9.1 , WEIBULL PARAMETERS A= 1.5 , B= 8.09 , C= 4.16
PERCENT SURVIVAL= 35.5 , MEAN CROWN RATIO= 24.0 , LAMBDA= .335
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

YIELDS GIVEN T_P WITH IDEAL SURVIVAL —

T_P 1500

S_I 80

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
15	54	2	5	.1	27	21	2	1						
		3	36	1.8	30	33	37	21						
		4	115	10.0	32	41	237	147						
		5	228	31.1	34	47	803	528	749	499	695	466	443	293
		6	289	56.7	35	51	1551	1059	1464	1011	1403	973	1225	854
		7	218	58.3	36	54	1729	1216	1646	1168	1611	1146	1519	1085
		8	86	30.0	37	57	939	673	897	648	885	640	856	621
		9	15	6.6	38	59	214	155	205	150	203	149	199	146
		10	1	.5	39	61	18	13	17	13	17	13	17	13
			993	195.2			5530	3813	4978	3489	4814	3387	4259	3012

ARITH. MEAN DBH= 5.9 , QUADRATIC MEAN DBH= 6.0 , WEIBULL PARAMETERS A= 1.0 , B= 5.38 , C= 4.22
PERCENT SURVIVAL= 66.2 , MEAN CROWN RATIO= 34.8 , LAMBDA= .281
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
25	80	2	1	.0	18	22	0	0						
		3	8	.4	20	39	9	5						
		4	27	2.4	21	51	66	42						
		5	63	8.6	23	61	273	183	257	174	237	162	137	91
		6	109	21.4	24	68	741	515	706	496	674	476	583	414
		7	146	39.0	24	74	1452	1036	1393	1002	1360	981	1268	918
		8	150	52.4	25	78	2043	1484	1969	1441	1939	1422	1863	1370
		9	112	49.5	26	82	2024	1492	1955	1451	1937	1439	1892	1408
		10	58	31.6	27	85	1342	1000	1299	974	1290	968	1267	953
		11	19	12.5	27	88	551	415	535	405	532	403	525	398
		12	4	3.1	28	90	142	107	138	105	137	105	136	104
			697	220.9			8643	6279	8252	6048	8106	5956	7671	5656

ARITH. MEAN DBH= 7.4 , QUADRATIC MEAN DBH= 7.6 , WEIBULL PARAMETERS A= 1.2 , B= 6.85 , C= 4.02
PERCENT SURVIVAL= 46.5 , MEAN CROWN RATIO= 24.8 , LAMBDA= .270
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
35	97	3	2	.1	16	35	2	1						
		4	8	.7	18	50	19	12						
		5	20	2.7	19	62	88	59	83	56	76	52	44	29
		6	39	7.7	20	72	278	194	265	187	253	179	219	156
		7	60	16.0	21	80	638	457	613	443	599	433	558	405
		8	77	26.9	22	86	1143	834	1104	811	1087	800	1043	770
		9	83	36.7	22	91	1646	1218	594	1187	1578	1177	1541	1151
		10	68	37.1	23	96	1755	1314	1704	1283	1691	1275	1661	1254
		11	44	29.0	24	100	1433	1083	1394	1059	1387	1054	1369	1042
		12	21	16.5	24	103	841	640	819	627	816	625	809	620
		13	7	6.5	25	106	340	260	331	255	330	255	328	253
		14	2	2.1	25	109	116	90	113	88	113	88	112	87
			431	182.0			8299	6162	8020	5996	7930	5938	7684	5767

ARITH. MEAN DBH= 8.6 , QUADRATIC MEAN DBH= 8.8 , WEIBULL PARAMETERS A= 1.4 , B= 7.88 , C= 3.95
PERCENT SURVIVAL= 28.7 , MEAN CROWN RATIO= 22.1 , LAMBDA= .314
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

Appendix 3.

Yield tables given site index, age, and number of trees planted with typical survival expected.

YIELDS GIVEN T_P, WITH TYPICAL SURVIVAL —

T_P 500

S_I 40

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	ALL TREES GROUND TO TIP I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
15	27	1	2	.0	29	5	0	0						
		2	21	.5	41	13	5	2						
		3	62	3.0	50	19	39	20						
		4	98	8.6	56	23	122	72						
		5	96	13.1	61	25	202	126	182	116	170	109	133	84
		6	56	11.0	66	28	186	122	171	113	165	110	150	100
		7	18	4.8	69	29	84	57	77	53	76	52	72	49
		8	3	1.0	73	30	19	13	17	12	17	12	17	12
			356	42.0			657	412	447	294	428	283	372	245

ARITH. MEAN DBH= 4.5 , QUADRATIC MEAN DBH= 4.6 , WEIBULL PARAMETERS A= .6 , B= 4.33 , C= 3.33
PERCENT SURVIVAL= 71.2 , MEAN CROWN RATIO= 58.8 , LAMBDA= .649
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	ALL TREES GROUND TO TIP I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
25	40	1	1	.0	19	5	0	0						
		2	8	.2	28	11	2	1						
		3	22	1.1	35	19	16	8						
		4	41	3.6	40	26	57	34						
		5	55	7.5	44	31	139	88	127	82	118	77	87	56
		6	56	11.0	48	35	226	150	210	142	202	137	182	124
		7	48	12.8	51	38	278	191	260	181	255	178	242	169
		8	31	10.8	54	40	245	172	231	164	227	162	220	157
		9	15	6.6	57	42	156	111	147	106	146	105	143	103
		10	6	3.3	59	44	80	58	75	55	75	55	74	54
		11	1	.7	62	45	16	12	15	11	15	11	15	11
			284	57.5			1215	825	1065	741	1038	725	963	674

ARITH. MEAN DBH= 5.8 , QUADRATIC MEAN DBH= 6.1 , WEIBULL PARAMETERS A= .8 , B= 5.65 , C= 2.98
PERCENT SURVIVAL= 56.8 , MEAN CROWN RATIO= 47.4 , LAMBDA= .624
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	ALL TREES GROUND TO TIP I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
35	48	1	1	.0	15	5	0	0						
		2	6	.1	23	9	1	0						
		3	15	.7	28	18	10	5						
		4	25	2.2	33	26	37	22						
		5	33	4.5	37	32	85	54	78	51	72	47	54	35
		6	37	7.3	40	37	156	104	145	99	140	95	126	86
		7	36	9.6	43	41	225	156	213	148	208	146	198	139
		8	29	10.1	46	44	253	179	239	171	236	169	229	164
		9	21	9.3	49	47	245	176	233	169	231	168	226	165
		10	13	7.1	51	49	189	138	180	132	179	132	176	130
		11	7	4.6	53	51	126	93	120	90	120	89	118	88
		12	3	2.4	55	53	66	49	63	47	63	47	62	47
		13	1	.9	57	54	26	20	25	19	25	19	24	19
			227	58.8			1420	996	1296	926	1274	912	1213	873

ARITH. MEAN DBH= 6.5 , QUADRATIC MEAN DBH= 6.9 , WEIBULL PARAMETERS A= .8 , B= 6.41 , C= 2.65
PERCENT SURVIVAL= 45.4 , MEAN CROWN RATIO= 42.1 , LAMBDA= .641
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

YIELDS GIVEN T_P WITH TYPICAL SURVIVAL —

T_P 750

S_I 40

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
15	27	1	10	.1	29	5	0	0						
		2	58	1.3	41	15	14	6						
		3	119	5.8	49	20	77	40						
		4	142	12.4	56	24	183	108						
		5	105	14.3	61	26	228	143	205	131	192	123	149	95
		6	47	9.2	65	28	155	102	143	95	138	92	126	84
		7	12	3.2	58	29	56	38	52	35	51	35	48	33
		8	2	.7	71	30	13	9	12	8	11	8	11	8
			495	47.0			726	446	412	269	392	258	334	220

ARITH. MEAN DBH= 4.0 , QUADRATIC MEAN DBH= 4.2 , WEIBULL PARAMETERS A= .4 , B= 3.97 , C= 2.97
PERCENT SURVIVAL= 66.0 , MEAN CROWN RATIO= 55.4 , LAMBDA= .613
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES GROUND TO TIP O.B.	I.B.	2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
25	40	1	3	.0	20	5	0	0						
		2	19	.4	28	13	5	2						
		3	43	2.1	34	21	33	17						
		4	64	5.6	39	28	94	56						
		5	73	10.0	43	32	188	120	172	112	160	105	118	77
		6	69	13.5	47	36	284	190	265	179	255	173	229	156
		7	51	13.6	50	38	301	207	282	196	276	192	263	183
		8	31	10.8	53	40	245	172	231	164	227	162	220	157
		9	15	6.6	55	42	156	111	147	106	146	105	143	103
		10	6	3.3	57	44	80	58	75	55	75	55	74	54
		11	2	1.3	59	45	32	24	31	23	31	23	30	22
			376	67.3			1418	957	1203	835	1170	815	1077	752

ARITH. MEAN DBH= 5.4 , QUADRATIC MEAN DBH= 5.7 , WEIBULL PARAMETERS A= .6 , B= 5.35 , C= 2.69
PERCENT SURVIVAL= 50.1 , MEAN CROWN RATIO= 44.6 , LAMBDA= .594
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES GROUND TO TIP O.B.	I.B.	2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
35	48	1	2	.0	15	5	0	0						
		2	12	.3	22	10	3	1						
		3	25	1.2	28	19	18	9						
		4	37	3.2	32	27	56	34						
		5	44	6.0	36	33	116	75	107	69	99	65	73	[illegible]
		6	42	8.2	39	37	177	119	165	112	159	[illegible]	[illegible]	97
		7	40	10.7	42	41	251	173	236	165	[illegible]	[illegible]	[illegible]	[illegible]
		8	32	11.2	45	44	279	197	254	189	261	186	[illegible]	181
		9	22	9.7	47	46	252	181	239	173	237	[illegible]	[illegible]	169
		10	14	7.6	49	49	209	152	199	146	[illegible]	145	[illegible]	143
		11	8	5.3	51	50	142	105	135	101	[illegible]	[illegible]	[illegible]	99
		12	4	3.1	53	52	86	65	92	62	82	[illegible]	[illegible]	51
		13	2	1.8	55	53	51	38	49	37	[illegible]	[illegible]	[illegible]	[illegible]
		14	1	1.1	57	54	30	23	28	22	28	[illegible]	[illegible]	[illegible]
			285	69.5			1670	1172	1504	1075	477	[illegible]	[illegible]	[illegible]

ARITH. MEAN DBH= 6.2 , QUADRATIC MEAN DBH= 6.7 , WEIBULL PARAMETERS A= .7 , B= 6.16 , C= 2.41
PERCENT SURVIVAL= 38.0 , MEAN CROWN RATIO= 39.8 , LAMBDA= .6
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

YIELDS GIVEN T_P WITH TYPICAL SURVIVAL —

T_P 1000

S_I 40

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME — ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
15	27	1	28	.2	30	6	1	0						
		2	105	2.3	41	16	26	10						
		3	172	8.4	49	21	115	60						
		4	167	14.6	55	24	215	126						
		5	103	14.0	60	27	229	144	207	133	194	125	149	96
		6	40	7.9	64	28	133	87	122	81	118	79	107	72
		7	10	2.7	67	29	47	31	43	29	42	29	40	27
		8	1	.3	70	30	6	4	6	4	6	4	6	4
			626	50.4			772	462	378	247	360	237	302	199

ARITH. MEAN DBH= 3.6 , QUADRATIC MEAN DBH= 3.8 , WEIBULL PARAMETERS A= .3 , B= 3.72 , C= 2.73
PERCENT SURVIVAL= 62.6 , MEAN CROWN RATIO= 53.0 , LAMBDA= .588
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	I.B.	2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
25	40	1	7	.0	20	5	0	0						
		2	33	.7	28	14	9	4						
		3	63	3.1	34	22	49	26						
		4	84	7.3	38	28	124	74						
		5	88	12.0	42	32	227	145	208	135	193	126	143	92
		6	75	14.7	46	36	309	207	288	195	277	188	249	170
		7	53	14.2	49	38	312	215	293	204	287	200	273	191
		8	31	10.8	51	40	245	172	231	164	227	162	220	157
		9	15	6.6	54	42	156	111	147	106	146	105	143	103
		10	6	3.3	56	43	78	57	74	54	73	54	72	53
		11	2	1.3	58	44	32	23	30	22	30	22	30	22
		12	1	.8	60	45	19	14	18	14	18	14	18	13
			458	74.9			1560	1048	1289	894	1251	871	1148	801

ARITH. MEAN DBH= 5.1 , QUADRATIC MEAN DBH= 5.5 , WEIBULL PARAMETERS A= .5 , B= 5 14 , C= 2.48
PERCENT SURVIVAL= 45.8 , MEAN CROWN RATIO= 42.6 , LAMBDA= .572
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	I.B.	2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
35	48	1	4	.0	15	5	0	0						
		2	19	.4	22	11	4	2						
		3	35	1.7	27	20	26	13						
		4	46	4.0	31	28	72	43						
		5	52	7.1	35	34	143	92	132	86	123	81	86	56
		6	50	9.8	38	38	215	144	201	136	193	132	173	119
		7	43	11.5	41	42	275	191	259	181	254	178	241	169
		8	33	11.5	44	45	294	208	278	199	274	196	266	191
		9	23	10.2	46	47	269	193	255	185	253	184	248	180
		10	15	8.2	48	49	224	163	213	157	212	156	209	154
		11	8	5.3	50	51	149	110	142	106	141	105	140	104
		12	4	3.1	52	52	86	65	82	62	82	62	81	61
		13	2	1.8	53	53	51	38	49	37	48	37	48	37
		14	1	1.1	55	54	30	23	28	22	28	22	28	22
			335	75.8			1838	1285	1639	1171	1608	1153	1520	1093

ARITH. MEAN DBH= 6.0 , QUADRATIC MEAN DBH= 6.5 , WEIBULL PARAMETERS A= .7 , B= 5.98 , C= 2.23
PERCENT SURVIVAL= 33.5 , MEAN CROWN RATIO= 38.1 , LAMBDA= .599
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

YIELDS GIVEN T_P WITH TYPICAL SURVIVAL –

T_P 1500

S_I 40

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
15	27	1	96	.5	31	7	4	1						
		2	210	4.6	42	16	52	21						
		3	246	12.1	49	22	169	89						
		4	184	16.1	55	25	243	144						
		5	93	12.7	59	27	207	130	187	120	175	113	135	86
		6	32	6.3	63	28	106	70	98	65	94	63	86	57
		7	8	2.1	66	29	37	25	34	24	34	23	32	22
		8	1	.3	69	30	6	4	6	4	6	4	6	4
			870	54.7			824	484	325	213	309	203	259	169

ARITH. MEAN DBH= 3.1 , QUADRATIC MEAN DBH= 3.4 , WEIBULL PARAMETERS A= .1 , B= 3.36 , C= 2.38
PERCENT SURVIVAL= 58.0 , MEAN CROWN RATIO= 49.7 , LAMBDA= .552
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
25	40	1	23	.1	20	5	1	0						
		2	67	1.5	27	16	21	9						
		3	100	4.9	33	24	83	44						
		4	115	10.0	37	30	178	107						
		5	104	14.2	41	34	281	181	258	168	239	157	175	114
		6	82	16.1	44	36	338	226	315	213	303	206	272	186
		7	55	14.7	47	39	331	228	311	216	305	212	289	203
		8	32	11.2	49	40	258	181	243	172	239	170	233	166
		9	16	7.1	51	42	166	119	157	113	155	112	152	110
		10	7	3.8	53	43	91	65	86	63	85	63	84	62
		11	3	2.0	55	44	48	35	45	33	45	33	44	33
		12	1	.8	57	45	19	14	18	14	18	14	18	13
			605	86.3			1815	1210	1433	992	1389	967	1267	887

ARITH. MEAN DBH= 4.7 , QUADRATIC MEAN DBH= 5.1 , WEIBULL PARAMETERS A= .4 , B= 4.83 , C= 2.18
PERCENT SURVIVAL= 40.3 , MEAN CROWN RATIO= 39.7 , LAMBDA= 542
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
35	48	1	12	.1	15	5	0	0						
		2	35	.8	22	12	9	4						
		3	52	2.6	27	22	41	22						
		4	61	5.3	31	29	98	59						
		5	62	8.5	34	34	171	109	157	102	147	96	103	67
		6	56	11.0	37	39	246	166	230	157	221	151	198	136
		7	46	12.3	39	42	295	204	277	194	272	190	258	181
		8	35	12.2	42	45	311	220	295	211	291	208	282	202
		9	25	11.0	44	47	292	210	278	201	275	200	269	196
		10	16	8.7	46	48	235	171	223	164	222	163	219	161
		11	10	6.6	48	50	183	135	175	129	174	129	172	128
		12	6	4.7	50	51	132	98	126	94	126	94	125	94
		13	3	2.8	51	52	75	57	72	55	71	54	71	54
		14	1	1.1	53	53	29	22	28	21	28	21	28	21
		15	1	1.2	54	54	34	26	32	25	32	25	32	25
			421	88.8			2151	1503	1893	1353	1859	1331	1757	1265

ARITH. MEAN DBH= 5.6 , QUADRATIC MEAN DBH= 6.2 , WEIBULL PARAMETERS A= .5 , B= 5.73 , C= 1.99
PERCENT SURVIVAL= 28.1 , MEAN CROWN RATIO= 35.8 , LAMBDA- 574
CORRESPONDING SITE INDEX FOR BASE AGE 50= 56

YIELDS GIVEN T_P WITH TYPICAL SURVIVAL –

T_P 500

S_I 60

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.3.	I.B.	O.B.	I.B.
15	41	2	1	.0	33	14	0	0						
		3	7	.3	39	23	5	3						
		4	29	2.5	44	29	44	26						
		5	67	9.1	47	34	181	117	166	109	154	101	113	74
		6	101	19.8	50	38	435	292	406	276	391	267	350	240
		7	94	25.1	53	40	569	392	533	372	523	365	495	347
		8	46	16.1	55	42	379	267	357	254	352	251	341	244
		9	10	4.4	58	44	108	77	102	74	101	73	99	72
		10	1	.5	59	46	14	10	13	10	13	10	13	9
			356	78.0			1735	1184	1577	1095	1534	1067	1411	986

ARITH. MEAN DBH= 6.2 , QUADRATIC MEAN DBH= 6.3 , WEIBULL PARAMETERS A= 1.1 , B= 5.60 , C= 4.49
PERCENT SURVIVAL= 71.2 , MEAN CROWN RATIO= 50.9 , LAMBDA= .498
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.3.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
25	60	3	2	.1	28	25	2	1						
		4	9	.8	31	34	16	10						
		5	23	3.1	34	42	74	48	69	46	64	43	42	27
		6	41	8.1	36	48	214	146	202	139	194	134	172	120
		7	59	15.8	38	53	461	323	438	311	429	305	404	288
		8	62	21.6	40	57	677	485	647	467	638	462	617	448
		9	50	22.1	42	60	724	526	694	509	687	504	672	494
		10	27	14.7	44	63	503	371	484	359	480	357	473	352
		11	9	5.9	45	65	208	155	200	150	199	149	197	148
		12	2	1.6	47	67	56	42	54	41	54	41	54	40
			284	93.8			2935	2107	2788	2022	2745	1995	2631	1917

ARITH. MEAN DBH= 7.6 , QUADRATIC MEAN DBH= 7.8 , WEIBULL PARAMETERS A= 1.3 , B= 6.93 , C= 4.15
PERCENT SURVIVAL= 55.8 , MEAN CROWN RATIO= 39.5 , LAMBDA= .473
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.3.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
35	73	3	2	.1	22	23	2	1						
		4	6	.5	25	34	11	7						
		5	13	1.8	28	43	43	28	40	26	37	25	24	16
		6	24	4.7	30	51	129	88	122	84	117	81	102	71
		7	35	9.4	32	57	279	196	265	188	259	164	243	174
		8	40	14.0	34	63	453	326	434	315	428	311	412	300
		9	41	18.1	35	67	621	454	597	439	591	435	576	42
		10	33	18.0	37	71	685	507	661	493	657	490	646	483
		11	20	13.2	38	74	520	389	502	378	500	376	494	373
		12	9	7.1	39	77	287	217	278	211	277	210	274	209
		13	3	2.8	41	79	114	87	111	85	110	84	110	84
		14	1	1.1	42	82	45	35	44	34	44	34	44	34
			227	90.6			3189	2335	3054	2253	3020	2230	2925	2169

ARITH. MEAN DBH= 8.3 , QUADRATIC MEAN DBH= 8.5 , WEIBULL PARAMETERS A= 1.4 , B= 7.68 , C= 3.81
PERCENT SURVIVAL= 45.4 , MEAN CROWN RATIO= 34.2 , LAMBDA= .490
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

YIELDS GIVEN T_P WITH TYPICAL SURVIVAL —

T_P 750

S_I 60

							CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
15	41	2	3	.1	33	17	1	0						
		3	22	1.1	38	26	17	9						
		4	66	5.8	42	32	107	65						
		5	123	16.8	46	36	348	225	320	210	296	195	216	141
		6	144	28.3	48	40	646	435	604	412	582	398	520	358
		7	98	26.2	51	42	618	427	581	406	569	398	538	378
		8	34	11.9	53	44	291	206	275	196	271	194	263	188
		9	5	2.2	55	46	56	40	53	39	53	38	52	37
			495	92.2			2084	1407	1833	1263	1771	1223	1589	1102

ARITH. MEAN DBH= 5.7 , QUADRATIC MEAN DBH= 5.8 , WEIBULL PARAMETERS A= .9 , B= 5 24 , C= 4 14
PERCENT SURVIVAL= 66.0 , MEAN CROWN RATIO= 47.5 , LAMBDA= .463
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

25	60	2	1	.0	23	15	0	0						
		3	6	.3	27	27	5	3						
		4	19	1.7	30	37	36	22						
		5	41	5.6	32	44	137	90	128	85	119	79	76	50
		6	66	13.0	35	50	349	238	329	227	315	218	276	192
		7	83	22.2	36	54	658	463	627	445	613	436	578	413
		8	76	26.5	38	58	842	604	805	583	794	575	768	558
		9	52	23.0	40	61	764	556	733	538	726	533	710	522
		10	24	13.1	41	63	447	329	430	319	427	317	421	313
		11	7	4.6	43	66	164	122	158	118	157	118	155	117
		12	1	.8	44	67	28	21	27	20	27	20	27	20
			376	110.7			3430	2448	3237	2335	3178	2296	3011	2185

ARITH. MEAN DBH= 7.1 , QUADRATIC MEAN DBH= 7.3 , WEIBULL PARAMETERS A= 1.1 , B= 6.62 , C= 3.85
PERCENT SURVIVAL= 50.1 , MEAN CROWN RATIO= 36.7 , LAMBDA= .443
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

35	73	3	3	.1	22	25	3	1						
		4	11	1.0	24	36	21	13						
		5	22	3.0	27	45	75	49	70	46	65	43	42	27
		6	35	6.9	29	53	194	133	183	127	175	122	153	107
		7	47	12.6	30	59	386	272	367	261	358	256	336	241
		8	52	18.2	32	64	597	430	572	415	564	410	543	405
		9	47	20.8	33	68	721	527	693	510	687	506	669	494
		10	35	19.1	35	72	699	518	674	502	669	499	658	492
		11	20	13.2	36	75	526	394	509	383	506	381	501	377
		12	9	7.1	37	77	287	217	278	211	277	210	274	209
		13	3	2.8	38	80	116	88	112	86	112	85	111	85
		14	1	1.1	39	82	45	35	44	34	44	34	44	34
			285	105.6			3670	2677	3502	2575	3457	2546	3331	2461

ARITH. MEAN DBH= 7.9 , QUADRATIC MEAN DBH= 8.2 , WEIBULL PARAMETERS A= 1.3 , B= 7.43 , C= 3.57
PERCENT SURVIVAL= 38.0 , MEAN CROWN RATIO= 31.9 , LAMBDA= .466
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

YIELDS GIVEN T_P WITH TYPICAL SURVIVAL —

T_P 1000

S_I 60

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
15	41	2	9	.2	32	18	3	1						
		3	45	2.2	37	27	35	19						
		4	112	9.8	41	33	186	113						
		5	175	23.9	44	37	506	328	466	306	430	285	313	205
		6	167	32.8	47	40	750	505	701	478	675	462	604	415
		7	91	24.3	49	42	583	403	549	384	537	377	510	359
		8	24	8.4	51	44	206	145	194	139	191	137	185	133
		9	3	1.3	53	46	34	24	32	23	32	23	31	22
			626	102.9			2303	1538	1942	1330	1865	1284	1643	1134

ARITH. MEAN DBH= 5.3 , QUADRATIC MEAN DBH= 5.5 , WEIBULL PARAMETERS A= .8 , B= 4.99 , C= 3.89
PERCENT SURVIVAL= 62.6 , MEAN CROWN RATIO= 45.1 , LAMBDA= .437
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
25	60	2	2	.0	22	17	1	0						
		3	12	.6	26	29	11	6						
		4	32	2.8	29	38	62	38						
		5	61	8.3	31	46	211	139	197	131	183	122	117	77
		6	88	17.3	33	51	472	323	446	308	427	296	373	260
		7	99	26.5	35	55	767	538	728	516	711	505	668	476
		8	83	29.0	37	59	934	670	894	647	881	639	852	619
		9	52	23.0	38	61	764	556	733	538	726	533	710	522
		10	22	12.0	39	64	416	305	400	297	397	295	391	291
		11	6	4.0	41	66	141	105	135	101	135	101	133	100
		12	1	.8	42	67	28	21	27	20	27	20	27	20
			458	124.2			3807	2702	3560	2558	3487	2511	3271	2365

ARITH. MEAN DBH= 6.8 , QUADRATIC MEAN DBH= 7.1 , WEIBULL PARAMETERS A= 1.1 , B= 6.41 , C= 3 64
PERCENT SURVIVAL= 45.8 , MEAN CROWN RATIO= 34.7 , LAMBDA= .422
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
35	73	2	1	.0	18	13	0	0						
		3	6	.3	21	26	5	3						
		4	16	1.4	24	38	31	19						
		5	30	4.1	26	47	106	69	98	66	91	61	58	38
		6	46	9.0	28	54	259	177	244	169	234	163	204	143
		7	57	15.2	29	60	475	335	452	322	441	315	414	296
		8	59	20.6	31	65	687	495	658	478	649	472	624	455
		9	51	22.5	32	69	793	580	762	562	755	557	736	544
		10	36	19.6	33	72	719	533	693	517	688	514	677	506
		11	20	13.2	34	75	503	376	486	366	483	364	477	360
		12	9	7.1	36	77	287	217	278	211	277	210	274	209
		13	3	2.8	37	80	116	88	112	86	112	85	111	85
		14	1	1.1	38	82	45	35	44	34	44	34	44	34
			335	116.9			4026	2927	3827	2811	3774	2775	3619	2670

ARITH. MEAN DBH= 7.7 , QUADRATIC MEAN DBH= 8.0 , WEIBULL PARAMETERS A= 1.2 , B= 7.25 , C= 3.40
PERCENT SURVIVAL= 33.5 , MEAN CROWN RATIO= 30.2 , LAMBDA= .448
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

YIELDS GIVEN T_P WITH TYPICAL SURVIVAL –

T_P 1500

S_I 60

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
15	41	1	2	.0	25	6	0	0						
		2	31	.7	32	19	11	5						
		3	110	5.4	36	28	89	48						
		4	210	18.3	39	33	349	212						
		5	249	34.0	42	37	720	466	663	435	612	405	445	291
		6	180	35.3	45	40	808	544	755	515	727	498	651	447
		7	72	19.2	47	42	461	319	434	304	425	298	403	284
		8	15	5.2	48	44	131	92	124	88	122	87	119	85
		9	1	.4	50	46	11	8	11	8	11	8	11	8
			870	118.6			2580	1694	1987	1350	1897	1296	1629	1115

ARITH. MEAN DBH= 4.8 , QUADRATIC MEAN DBH= 5.0 , WEIBULL PARAMETERS A= .7 , B= 4.63 , C= 3.54
PERCENT SURVIVAL= 58.0 , MEAN CROWN RATIO= 41.8 , LAMBDA= .402
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
25	60	2	6	.1	22	19	2	1						
		3	27	1.3	25	31	27	15						
		4	61	5.3	27	40	124	76						
		5	99	13.5	29	47	[illegible]	229	325	217	302	202	192	127
		6	125	24.5	31	52	681	466	643	445	617	428	538	375
		7	121	32.3	33	56	951	668	904	641	883	628	828	591
		8	90	31.4	34	59	965	691	921	666	907	657	875	635
		9	50	22.1	36	62	745	543	715	525	708	521	693	510
		10	20	10.9	37	64	378	279	363	270	361	268	356	265
		11	5	3.3	38	66	117	87	113	85	112	84	111	83
		12	1	.8	39	67	28	21	27	20	27	20	27	20
			605	145.7			4366	3076	4011	2869	3917	2808	3620	2606

ARITH. MEAN DBH= 6.4 , QUADRATIC MEAN DBH= 6.6 , WEIBULL PARAMETERS A= .9 , B= 6.10 , C= 3.34
PERCENT SURVIVAL= 40.3 , MEAN CROWN RATIO= 31.9 , LAMBDA= .392
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
35	73	2	3	.1	17	15	1	0						
		3	12	.6	20	29	11	6						
		4	28	2.4	22	40	57	35						
		5	47	6.4	24	49	171	113	160	107	148	100	88	58
		6	64	12.5	26	56	370	255	351	244	336	234	292	205
		7	71	19.0	27	61	599	423	571	407	557	398	522	375
		8	70	24.4	29	66	826	595	791	575	780	569	750	548
		9	56	24.7	30	70	881	645	847	625	840	620	818	605
		10	37	20.2	31	73	748	554	721	538	716	535	704	526
		11	20	13.2	32	75	503	376	486	366	483	364	477	360
		12	9	7.1	33	78	280	211	271	206	270	205	267	203
		13	3	2.8	34	80	113	86	109	83	109	83	106	83
		14	1	1.1	35	82	45	34	43	33	43	33	43	33
			421	134.5			4605	3333	4350	3184	4282	3140	4063	[illegible]

ARITH. MEAN DBH= 7.3 , QUADRATIC MEAN DBH= 7.6 , WEIBULL PARAMETERS A= 1.1 , B= [illegible] , C= 3 .5
PERCENT SURVIVAL= 28.1 , MEAN CROWN RATIO= 27.9 , LAMBDA= .424
CORRESPONDING SITE INDEX FOR BASE AGE 50= 85

YIELDS GIVEN T_P WITH TYPICAL SURVIVAL —

T_P 500

S_I 80

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                                                          -------------------------CUBIC FOOT VOLUME-------------------------
GROWING                                                    ALL TREES      5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET,
SEASONS  AV.          STEMS                                 GROUND        FOR O.B. TOPS OF --
 SINCE   D+C    DBH    PER      BASAL     CR     AV.        TO TIP        2 INCHES           3 INCHES              4 INCHES
 EST.    HT.           ACRE      AREA            HT.       O.B.   I.B.    O.B.   I.B.        O.B.   I.B.           O.B.   I.B.
------------------------------------------------------------------------------------------------------------------------------
  15      54     3        1        .0     34     27          1      0
                 4        6        .5     38     36         11      7
                 5       21       2.9     40     42         67     44      62     41          57     38             41     27
                 6       54      10.6     43     47        277    189     261    180         250    173            223    155
                 7       94      25.1     44     51        710    497     673    477         660    468            623    443

                 8      103      36.0     46     54       1072    766    1023    737        1009    728            976    706
                 9       61      26.9     48     57        844    612     808    591         800    586            783    574
                10       15       8.2     49     59        264    194     253    187         251    186            247    184
                11        1        .7     50     61         22     16      21     16          21     16             21     15
                       ----    ------                    -----  -----   -----  -----       -----  -----          -----  -----
                        356     110.9                     3268   2325    3101   2229        3048   2195           2914   2104

     ARITH. MEAN DBH=  7.4 ,     QUADRATIC MEAN DBH=  7.6 ,     WEIBULL PARAMETERS A= 1.5 ,  B=  6.50 ,  C= 5.31
                 PERCENT SURVIVAL= 71.2 ,        MEAN CROWN RATIO= 45.3 ,        LAMBDA=  .391
                                 CORRESPONDING SITE INDEX FOR BASE AGE 50=113



  25      80     4        2        .2     27     42          4      3
                 5        6        .8     29     52         23     15      21     14          20     13             12      8
                 6       17       3.3     30     60        104     72      99     69          95     66             82     58
                 7       34       9.1     32     67        311    220     297    213         290    208            271    195
                 8       55      19.2     33     73        707    512     680    496         670    490            644    472

                 9       66      29.2     34     77       1129    830    1088    806        1078    799           1053    782
                10       58      31.6     35     81       1285    956    1243    931        1234    925           1213    910
                11       33      21.8     36     84        963    723     934    706         929    703            919    695
                12       11       8.6     37     87        393    297     381    290         380    289            376    287
                13        2       1.8     38     90         86     66      83     64          83     64             83     63
                       ----    ------                    -----  -----   -----  -----       -----  -----          -----  -----
                        284     125.7                     5005   3694    4826   3589        4779   3557           4653   3470

     ARITH. MEAN DBH=  8.8 ,     QUADRATIC MEAN DBH=  9.0 ,     WEIBULL PARAMETERS A= 1.6 ,  B=  7.83 ,  C= 4.97
                 PERCENT SURVIVAL= 56.8 ,        MEAN CROWN RATIO= 34.0 ,        LAMBDA=  .367
                                 CORRESPONDING SITE INDEX FOR BASE AGE 50=113



  35      97     4        1        .1     21     42          2      1
                 5        4        .5     23     55         16     11      15     10          14      9              8      5
                 6       10       2.0     25     66         66     46      63     44          60     42             52     37
                 7       19       5.1     26     74        189    135     181    130         177    128            165    120
                 8       31      10.8     27     82        441    321     426    312         419    308            403    297

                 9       42      18.6     28     88        808    597     782    582         774    577            756    564
                10       45      24.5     29     93       1128    844    1095    824        1087    818           1068    805
                11       38      25.1     30     98       1215    918    1181    897        1175    893           1160    882
                12       24      18.8     31    102        952    725     927    710         924    707            916    702
                13       10       9.2     32    106        485    372     473    365         472    364            468    361
                14        3       3.2     32    109        174    134     170    132         170    132            169    131
                       ----    ------                    -----  -----   -----  -----       -----  -----          -----  -----
                        227     117.9                     5476   4104    5313   4006        5272   3978           5165   3904

     ARITH. MEAN DBH=  9.6 ,     QUADRATIC MEAN DBH=  9.8 ,     WEIBULL PARAMETERS A= 1.7 ,  B=  8.58 ,  C= 4.63
                 PERCENT SURVIVAL= 45.4 ,        MEAN CROWN RATIO= 28.6 ,        LAMBDA=  .384
                                 CORRESPONDING SITE INDEX FOR BASE AGE 50=113
```

YIELDS GIVEN T_P WITH TYPICAL SURVIVAL –

T_P 750

S_I 80

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O B.	I.B.	O.B.	I.B.
15	54	3	3	.1	33	31	3	2						
		4	16	1.4	36	39	30	19						
		5	51	7.0	38	45	172	113	160	107	147	99	104	69
		6	106	20.8	40	50	573	392	540	374	519	360	460	321
		7	147	39.3	42	54	1166	820	1110	788	1087	773	1024	731
		8	118	41.2	44	56	1268	908	1211	875	1195	864	1156	838
		9	47	20.8	45	59	670	487	642	471	636	467	622	457
		10	7	3.8	46	61	127	93	122	90	121	90	119	88
			495	134.4			4009	2834	3785	2705	3705	2653	3485	2504

ARITH. MEAN DBH= 6.9 , QUADRATIC MEAN DBH= 7.0 , WEIBULL PARAMETERS A= 1.3 , B= 6.14 , C= 4 96
PERCENT SURVIVAL= 66.0 , MEAN CROWN RATIO= 41.9 , LAMBDA= .356
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

25	80	3	1	.0	23	32	1	1						
		4	4	.3	25	45	9	6						
		5	14	1.9	27	55	56	37	52	35	48	33	28	19
		6	32	6.3	28	63	204	141	194	136	185	130	161	114
		7	58	15.5	30	69	543	386	520	373	508	365	474	342
		8	81	28.3	31	74	1054	764	1014	740	999	731	960	704
		9	86	38.0	32	78	1488	1094	1435	1063	1421	1054	1389	1031
		10	62	33.8	33	82	1389	1034	1344	1007	1334	1000	1311	984
		11	29	19.1	34	85	815	613	790	598	786	595	776	588
		12	8	6.3	34	88	278	210	269	205	268	205	266	203
		13	1	.9	35	90	42	32	41	31	40	31	40	31
			376	150.5			5879	4318	5659	4188	5589	4144	5405	4016

ARITH. MEAN DBH= 8.4 , QUADRATIC MEAN DBH= 8.6 , WEIBULL PARAMETERS A= 1.5 , B= 7.53 , C= 4.67
PERCENT SURVIVAL= 50.1 , MEAN CROWN RATIO= 31.1 , LAMBDA= .336
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

35	97	4	2	.2	20	45	4	3						
		5	7	1.0	22	58	29	19	27	18	25	17	15	10
		6	16	3.1	23	68	109	76	104	73	99	70	85	61
		7	30	8.0	24	76	305	218	293	211	286	207	267	193
		8	44	15.4	25	83	633	461	611	448	602	442	578	426
		9	57	25.2	26	89	1108	819	1072	798	1062	791	1037	774
		10	54	29.5	27	94	1367	1023	1327	999	1317	992	1294	976
		11	41	27.1	28	99	1323	1000	1287	978	1280	973	1253	961
		12	23	18.1	28	102	913	695	889	680	885	678	878	673
		13	9	8.3	29	106	437	335	426	328	424	327	422	325
		14	2	2.1	30	109	116	90	113	88	113	88	112	87
			285	137.8			6344	4739	6149	4621	6093	4585	5952	4486

ARITH. MEAN DBH= 9.2 , QUADRATIC MEAN DBH= 9.4 , WEIBULL PARAMETERS A= 1.6 , B= 8.33 , C= 4.39
PERCENT SURVIVAL= 38.0 , MEAN CROWN RATIO= 26.3 , LAMBDA= 359
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

YIELDS GIVEN T_P WITH TYPICAL SURVIVAL –

T_P 1000

S_I 80

							CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR C.B. TOPS OF --					
GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.			2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
15	54	2	1	.0	29	20	0	0						
		3	7	.3	32	32	7	4						
		4	33	2.9	35	40	67	41						
		5	89	12.1	37	46	306	202	284	190	261	176	185	123
		6	160	31.4	39	51	879	603	830	575	796	554	706	493
		7	181	48.4	40	54	1436	1010	1366	970	1338	952	1261	900
		8	116	40.5	42	57	1266	907	1210	875	1193	864	1154	833
		9	35	15.5	43	59	499	363	478	350	474	347	463	340
		10	4	2.2	44	61	72	53	70	52	69	51	68	51
			626	153.3			4532	3183	4238	3012	4131	2944	3837	2745

ARITH. MEAN DBH= 6.6 , QUADRATIC MEAN DBH= 6.7 , WEIBULL PARAMETERS A= 1.2 , B= 5.89 , C= 4.71
PERCENT SURVIVAL= 62.6 , MEAN CROWN RATIO= 39.5 , LAMBDA= .330
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

25	80	3	2	.1	22	34	2	1						
		4	8	.7	24	47	18	11						
		5	23	3.1	26	56	93	62	87	59	81	55	47	31
		6	49	9.6	27	64	317	219	301	211	288	202	249	176
		7	81	21.6	28	70	768	546	736	528	719	517	670	484
		8	103	36.0	29	75	1356	983	1305	953	1286	941	1236	907
		9	96	42.4	30	79	1679	1236	1620	1201	1605	1190	1568	1165
		10	63	34.4	31	82	1412	1051	1365	1023	1355	1016	1332	1000
		11	26	17.2	32	85	731	550	708	536	705	533	696	527
		12	6	4.7	32	88	208	158	202	154	201	153	199	152
		13	1	.9	33	90	42	32	41	31	40	31	40	31
			458	170.7			6626	4849	6365	4696	6280	4638	6037	4473

ARITH. MEAN DBH= 8.1 , QUADRATIC MEAN DBH= 8.3 , WEIBULL PARAMETERS A= 1.4 , B= 7.31 , C= 4.46
PERCENT SURVIVAL= 45.8 , MEAN CROWN RATIO= 29.1 , LAMBDA= .315
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

35	97	3	1	.0	18	32	1	1						
		4	4	.3	19	47	9	6						
		5	11	1.5	21	59	46	31	44	29	40	27	23	16
		6	23	4.5	22	69	158	110	151	106	144	102	125	88
		7	40	10.7	23	78	416	298	400	288	390	282	364	264
		8	56	19.5	24	84	814	593	786	577	774	569	743	548
		9	65	28.7	25	90	1276	944	1236	920	1223	912	1195	892
		10	60	32.7	25	95	1534	1148	1489	1121	1478	1113	1452	1095
		11	43	28.4	26	99	1388	1048	1350	1025	1342	1020	1325	1008
		12	22	17.3	27	103	881	671	858	657	854	655	847	649
		13	8	7.4	27	106	388	298	378	292	377	291	375	289
		14	2	2.1	28	109	116	90	113	88	113	88	112	87
			335	153.3			7027	5238	6805	5103	6735	5059	6561	4936

ARITH. MEAN DBH= 9.0 , QUADRATIC MEAN DBH= 9.2 , WEIBULL PARAMETERS A= 1.5 , B= 8.15 , C= 4.22
PERCENT SURVIVAL= 33.5 , MEAN CROWN RATIO= 24.6 , LAMBDA= .341
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

YIELDS GIVEN T_P WITH TYPICAL SURVIVAL —

T_P 1500

S_I 80

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I B	O.B.	I.B.
15	54	2	3	.1	28	21	1	0						
		3	23	1.1	31	33	24	13						
		4	82	7.2	33	41	169	105						
		5	179	24.4	35	47	630	414	588	392	545	366	348	230
		6	252	49.5	36	51	1385	949	1307	906	1254	873	1112	777
		7	214	57.2	37	54	1698	1194	1616	1147	1582	1125	1491	1065
		8	97	33.9	39	57	1059	759	1012	731	998	722	965	700
		9	19	8.4	40	59	271	197	260	190	257	189	252	185
		10	1	.5	41	61	18	13	17	13	17	13	17	13
			870	182.2			5255	3644	4800	3379	4653	3288	4185	2970

ARITH. MEAN DBH= 6.1 , QUADRATIC MEAN DBH= 6.2 , WEIBULL PARAMETERS A= 1.0 , B= 5.53 , C= 4.36
PERCENT SURVIVAL= 58.0 , MEAN CROWN RATIO= 36.2 , LAMBDA= .295
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

25	80	3	5	.2	21	38	6	3						
		4	18	1.6	22	50	43	27						
		5	46	6.3	24	60	197	132	185	125	171	117	99	66
		6	85	16.7	25	67	571	397	543	381	519	366	449	318
		7	122	32.6	26	73	1199	855	1150	827	1123	809	1047	758
		8	136	47.5	27	78	1853	1346	1785	1306	1758	1289	1689	1242
		9	108	47.7	27	82	1952	1439	1886	1399	1868	1387	1824	1357
		10	60	32.7	28	85	1388	1035	1344	1008	1334	1001	1311	985
		11	21	13.9	29	87	603	454	585	442	582	440	574	435
		12	4	3.1	29	90	142	107	138	105	137	105	136	104
			605	202.3			7954	5795	7616	5593	7492	5514	7129	5265

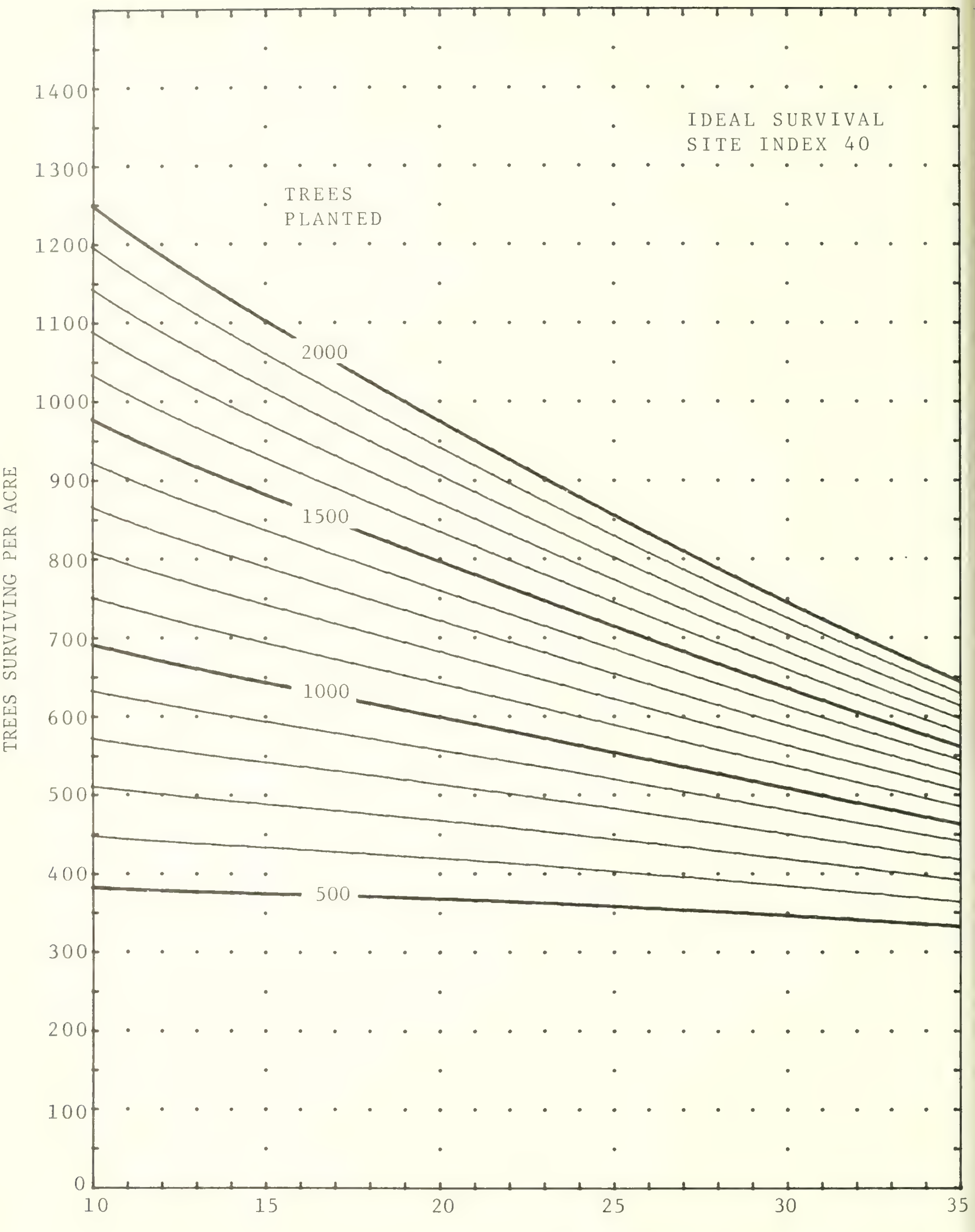
ARITH. MEAN DBH= 7.6 , QUADRATIC MEAN DBH= 7.8 , WEIBULL PARAMETERS A= 1.3 , B= 7.01 , C= 4.17
PERCENT SURVIVAL= 40.3 , MEAN CROWN RATIO= 26.3 , LAMBDA= .285
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

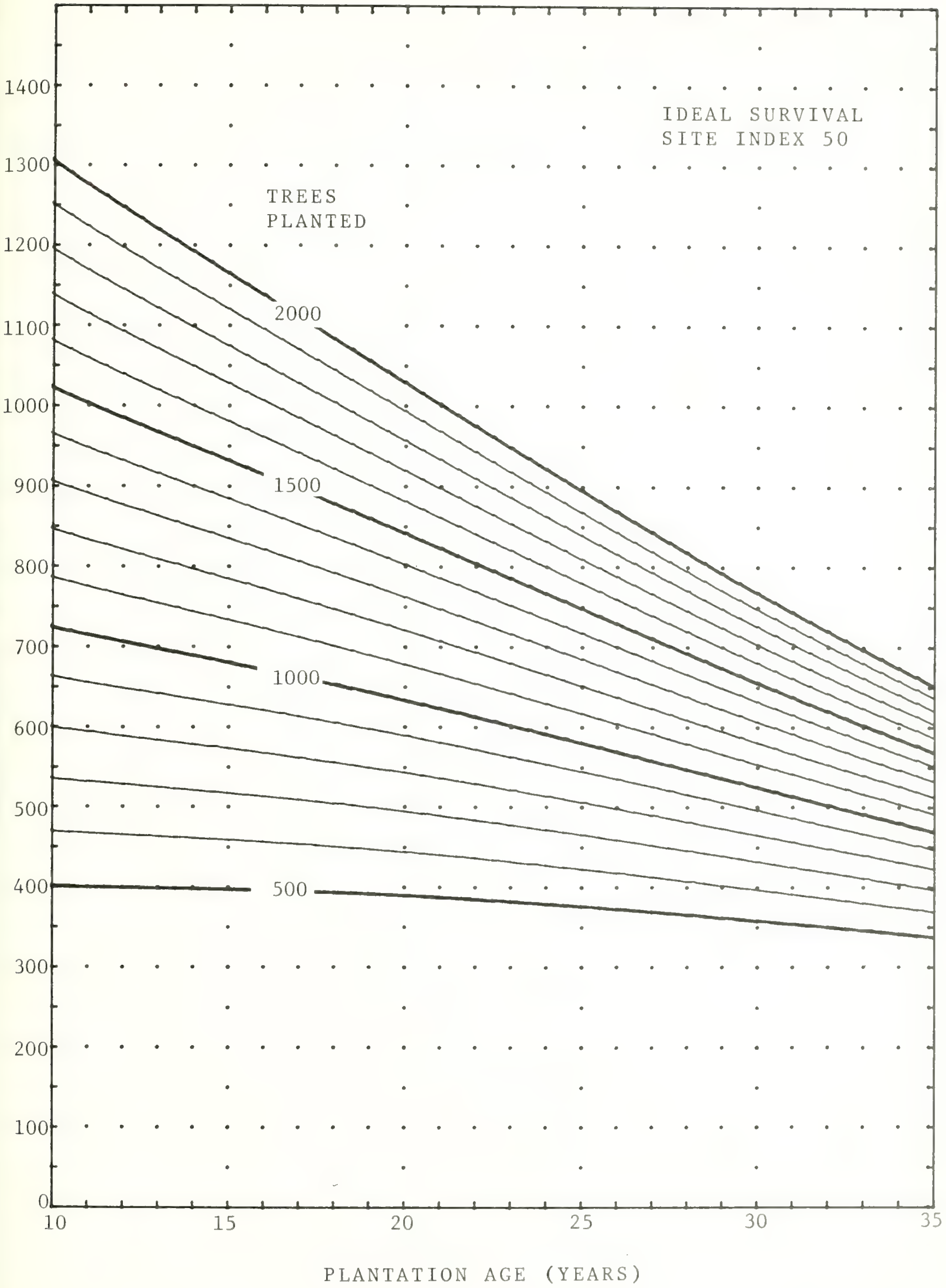
35	97	3	2	.1	17	34	2	1						
		4	8	.7	18	50	19	12						
		5	19	2.6	19	62	83	56	78	53	72	50	42	28
		6	37	7.3	20	71	261	182	249	175	237	168	205	146
		7	58	15.5	21	79	610	437	586	423	572	414	533	387
		8	75	26.2	22	86	1113	812	1075	790	1059	779	1016	750
		9	81	35.8	23	91	1606	1188	1555	1158	1540	1148	1504	1123
		10	67	36.5	23	96	1729	1294	1679	1264	1666	1255	1637	1235
		11	44	29.0	24	100	1433	1083	1394	1059	1387	1054	1369	1042
		12	21	16.5	24	103	841	640	819	627	816	625	809	620
		13	7	6.5	25	106	340	260	331	255	330	255	328	253
		14	2	2.1	26	109	116	90	113	88	113	88	112	87
			421	178.8			8153	6055	7879	5892	7792	5837	7555	5671

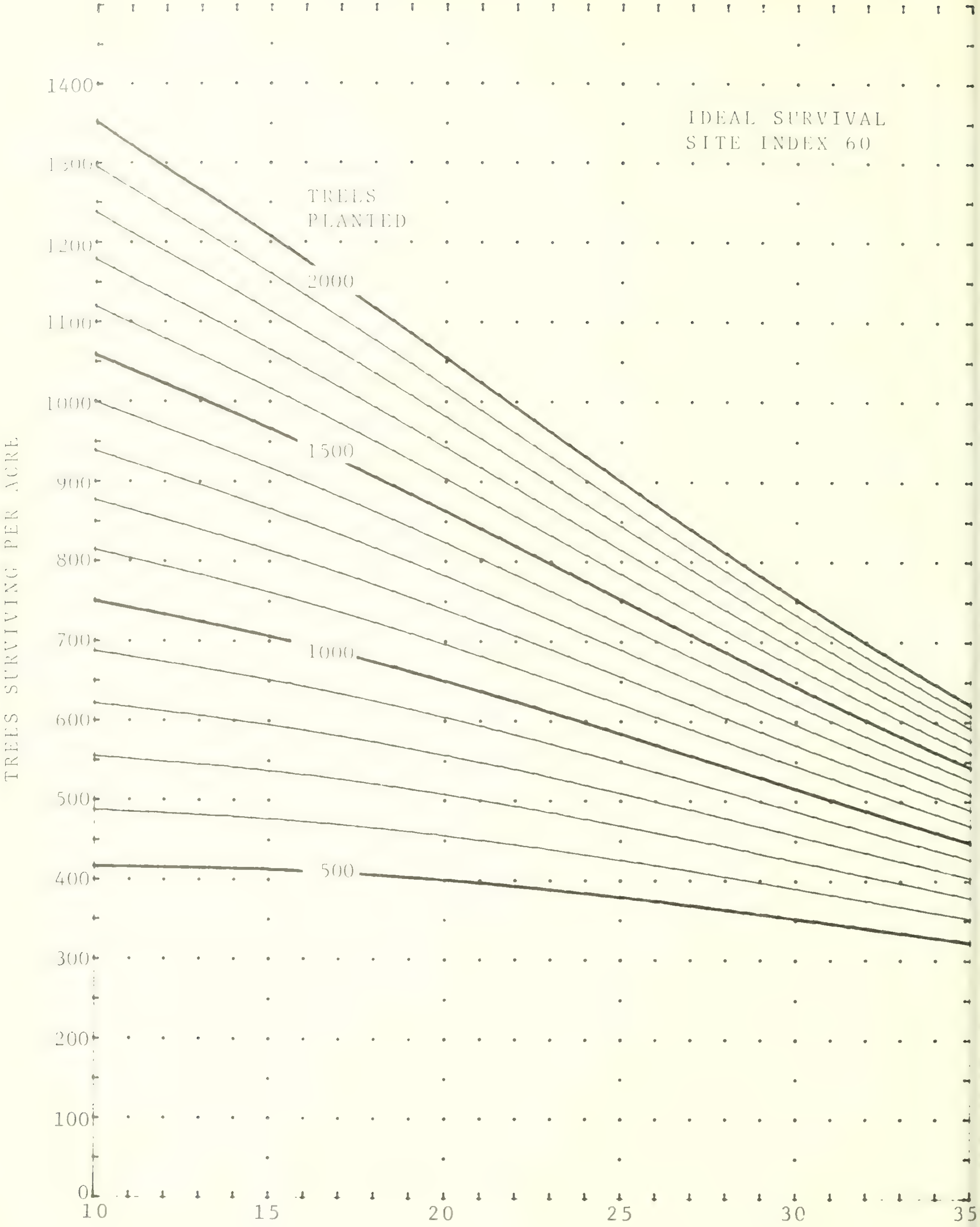
ARITH. MEAN DBH= 8.6 , QUADRATIC MEAN DBH= 8.8 , WEIBULL PARAMETERS A= 1.4 , B= 7.90 , C= 3.98
PERCENT SURVIVAL= 28.1 , MEAN CROWN RATIO= 22.3 , LAMBDA= .317
CORRESPONDING SITE INDEX FOR BASE AGE 50=113

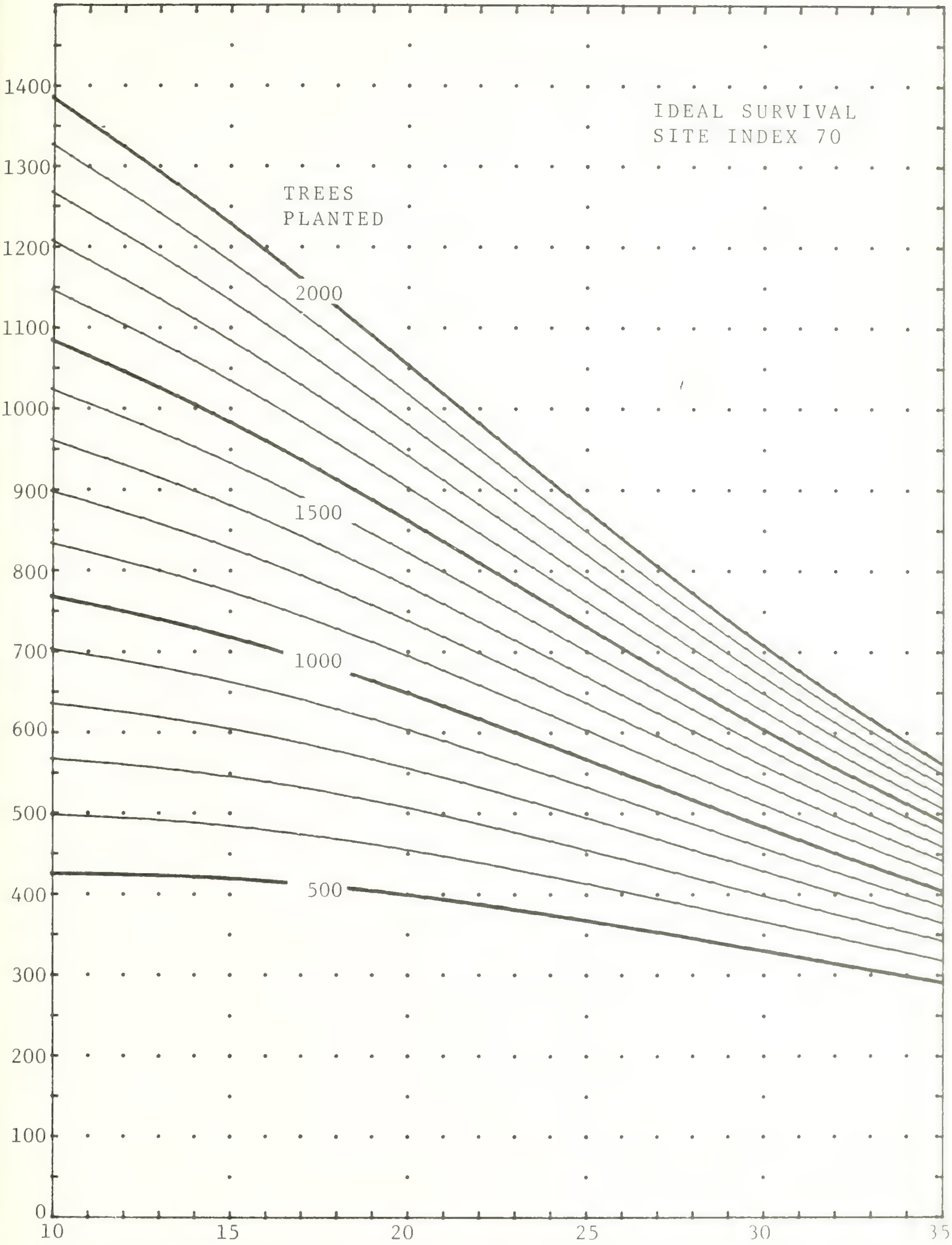
Appendix 4.

Figures to predict surviving number of trees using ideal survival.


IDEAL SURVIVAL
SITE INDEX 40
TREES
PLANTED
2000
1500
1000
500
TREES SURVIVING PER ACRE
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
10
15
20
25
30
35
PLANTATION AGE (YEARS)


IDEAL SURVIVAL
SITE INDEX 50
TREES PLANTED
2000
1500
1000
500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
10
15
20
25
30
35
PLANTATION AGE (YEARS)

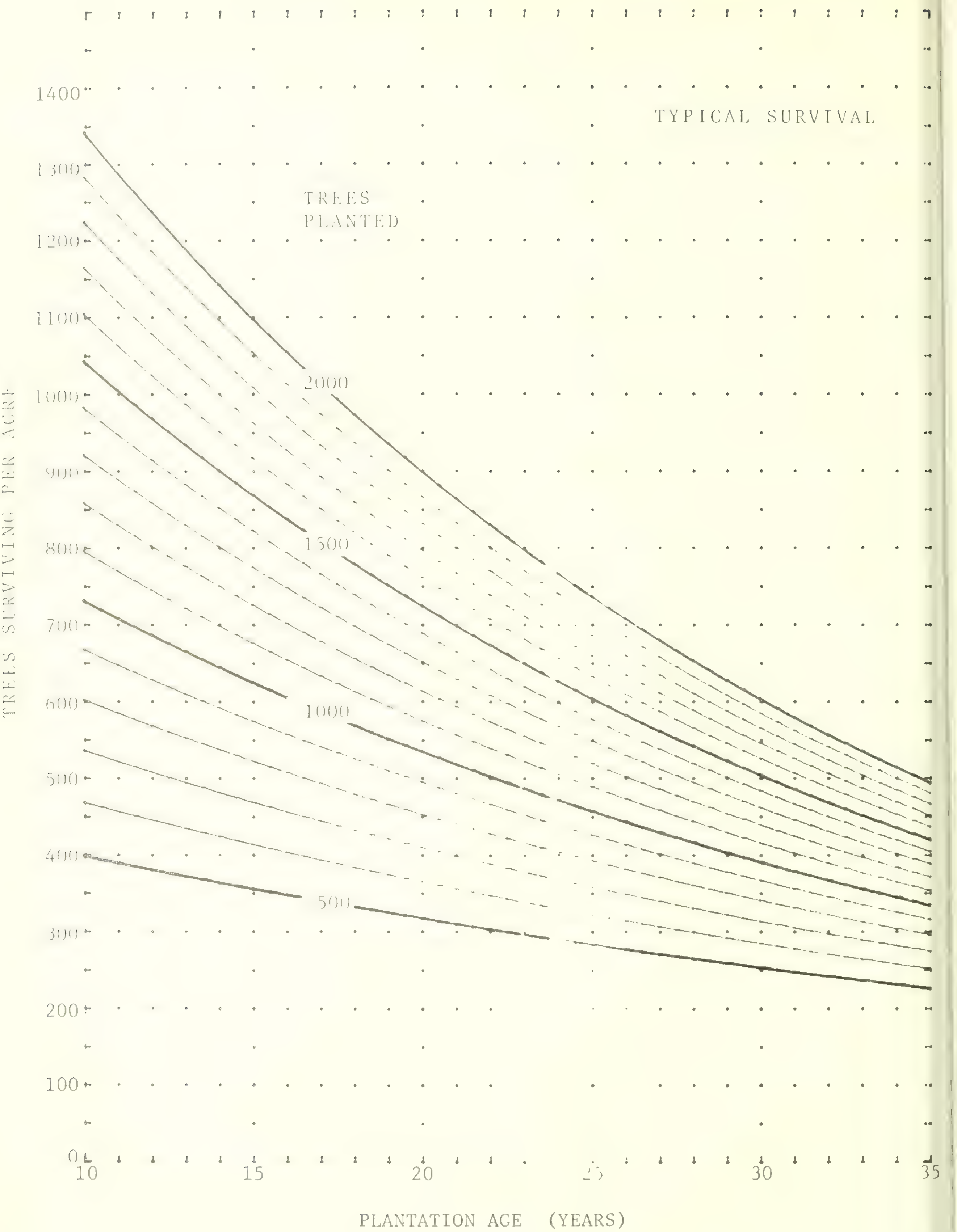

IDEAL SURVIVAL
SITE INDEX 60
TREES PLANTED
2000
1500
1000
500
TREES SURVIVING PER ACRE
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
PLANTATION AGE (YEARS)
10
15
20
25
30
35



PLANTATION AGE (YEARS)

Appendix 5.

Figure to predict surviving number of trees using typical survival.


TYPICAL SURVIVAL
TREES PLANTED
2000
1500
1000
500
TREES SURVIVING PER ACRE
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
10
15
20
25
30
35
PLANTATION AGE (YEARS)

Dell, T. R., D. P. Feduccia, T. E. Campbell, W. F. Mann, Jr., and B. H. Polmer.

1979, Yields of unthinned slash pine plantations on cutover sites in the west Gulf region, U.S. Dep. Agric. For. Serv. Res. Pap. SO-147, 84 p. South. For. Exp. Stn., New Orleans, La.

Detailed tables of trees per acre, basal area, average height, crown ratio, and cubic-foot volumes are presented by 1-inch diameter classes for several combinations of site index, plantation age, and (1) number of trees surviving, (2) number of trees planted and an ideal survival pattern, and (3) number of trees planted and a typical survival pattern.

Additional keywords: *Pinus elliottii* var. *elliotti,* volume predictions, unthinned plantation yields, volume yields of slash pine, Weibull distribution, taper curves, crown ratio, survival prediction, problem-free sites.

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Conversion to Metric Units

Cubic meters per hectare = Cubic feet per acre ÷ 14.2913
Square feet per hectare = Square feet per acre ÷ 4.356
Number per hectare = Number per acre × 2.471
Centimeters = Inches × 2.54
Meters = Feet × 0.3048

U.S. Department of Agriculture
Forest Service
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Yields of Unthinned Loblolly Pine Plantations on Cutover Sites in the West Gulf Region

D. P. FEDUCCIA, T. R. DELL, W. F. MANN, JR.,
T. E. CAMPBELL, AND B. H. POLMER

Southern
Forest
Experiment
Station

Summary

The system of equations presented here uses diameter distributions and tree taper functions to forecast in detail the development of unthinned loblolly pine plantations. Data were collected in parts of east Texas, Louisiana, southern Arkansas, and southern Mississippi. Only plantations established on cutover sites that did not require preparation were sampled. However, the results should serve as interim guides for yields in plantations where site preparation is employed. Two sets of yield tables are given, corresponding to predictions made from the site index, plantation age, and number of trees surviving or number of trees planted and the survival pattern expressed in the study data.

To enhance stand description, new techniques are presented for predicting crown ratio by d.b.h. class. Crown ratios are used to select the appropriate set of taper curves. The computer program USLYCOWG (unthinned slash and loblolly yields for cutover sites in the West Gulf region) that produces the yield tables can be obtained from the authors.

ACKNOWLEDGMENTS

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Kisatchie National Forest, Pineville, La.
Southwestern Timber Co., Jasper, Tex.
Rice Land and Lumber Co., Merryville, La.
Crown-Zellerbach, DeRidder and Bogalusa, La.
Louisiana Office of Forestry, Woodworth, La.

The computer routines developed by Robert L. Bailey and presented in Research Papers SO-96 and 97 provided the framework for the system reported here. Our efforts were also facilitated by information and computer routines provided by F. Thomas Lloyd and Edward W. Whitehorne of the Southeastern Forest Experiment Station.

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Yields of Unthinned Loblolly Pine Plantations on Cutover Sites in the West Gulf Region

BY
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T. E. CAMPBELL, AND B. H. POLMER

Loblolly pine (*Pinus taeda* L.) is a preferred species for planting in the South. We estimate that from 1970 through 1977 forest landowners in the West Gulf region planted about 1.3 million acres to loblolly. The number of acres planted in 1977 was double that planted in 1970, and the trend is expected to continue. Managers of loblolly plantations need accurate predictions of growth and yield in relation to site index, planting density, age, and percent survival in order to formulate management policies.

For unthinned loblolly plantations the only comprehensive yield tables previously available that specifically included the West Gulf region were by Coile and Schumacher (1964) and Lenhart (1972). The system of equations presented here improves forecasts of plantation development on cutover sites in the lower West Gulf Coastal Plain by using diameter distributions and stem taper functions. Coile and Schumacher's work did not utilize these techniques and Lenhart's yields involved unthinned, old field plantations located within the interior West Gulf Coastal Plain.

The data in this study were collected from plantations relatively free of establishment problems. The virgin stands were clearcut; grazing and repeated burning controlled woody vegetation, allowing successful establishment of planted pines without intensive site preparation.

Many such problem-free sites should be available in the future as pine density is carefully controlled throughout the rotation, and utilization is more complete at final harvest. Thus, our results may apply to repeated crops of pines in the region. Also, the results can be used—at least until better guides are published—to predict yields where site preparation is employed. Yield forecasts by various systems were used by Clutter and Dell (1978) to anticipate yield with site preparation.

In the text that follows we will explain the equations used in the system. Some readers may want to apply our system to circumstances not covered in the yield tables. To do so, the computer program USLYCOWG (unthinned slash and loblolly yields for cutover sites in the West Gulf region), which is written in FORTRAN, is available from the Southern Forest Experiment Station, Statistical Methods for Research and Application, T-10210, 701 Loyola Avenue, New Orleans, LA 70113.

Readers who wish to can proceed directly to the Applications section, which explains how to use the yield tables. First, however, it will be necessary to become familiar with the following notations:

A_p = Plantation age; the number of growing seasons since the seedlings were planted.

H_D = Average height of dominant and codominant trees at any given A_p.

S_I = Site index; the average height of dominant and codominant trees at a given reference age (I). In the tables, I is for plantation age 25.

T_p = Number of trees planted per acre.

T_s = Number of trees surviving at A_p.

Feduccia is Research Forester; Dell, Mathematical Statistician; Mann, Chief Silviculturist; Campbell, Silviculturist; and Polmer, Statistician. All are employed by the Southern Forest Experiment Station, Forest Service—USDA, except Feduccia, who is assigned to the Southern Station by the Louisiana Office of Forestry.

Plantation Data

Study plots were in unthinned loblolly pine plantations established on cutover forest land. Wildfires burned the idle lands frequently and prevented natural regeneration and hardwood brush invasion. On some areas the heavy grass rough that predominated was burned off before planting; on others, it was not. We selected plantations on areas of good survival and within plantations chose plots free of heavy insect, disease, or other damage.

Many of the data used in developing the prediction system were from records on unthinned plots of various sizes in 9 long-term stand density studies. Some plots had been remeasured from one to six times, at intervals of 1 to 5 years. In addition, 67 supplementary plots were installed to include specifically site, age, and initial planting density combinations not well represented in existing studies. Collectively, 409 plot observations were available and their geographic coverage is shown in figure 1. Summaries of the distributions of these observations are given in tables 1 through 3. Only limited data was available outside the following ranges: (1) ages 3 to 27, (2) sites 38 to 77, and (3) planting densities of 251 to 1,500 trees per acre.

The average height of dominant and codominant trees was obtained to determine site index. Diameter at breast height (d.b.h.) to the nearest 0.1 inch was measured for each tree on the plot. In addition, measurements were made on individual volume sample trees relating to total height, height to the base of the living crown, and upper stem outside bark diameters. However, these sample tree data were not consistently available for all plots.

Model Development

Site Index

The observations covered in this paper and from other sources were used to define a set of site index curves for the category of loblolly plantations and the geographic area considered in this paper. This development was prompted by the fact that application of existing curves for natural loblolly resulted in a persistently increasing estimate of site index with repeated measurements over time on the same plot. The same was true of the Coile and Schumacher (1964) curves for planted loblolly pine on drainage classes d_1 - d_4. In general, the problem-free cutover site plantations in the West Gulf were making more rapid height growth in the first 25 years than was expressed in the other curves. However, when compared with results from old fields in the same general vicinity (Lenhart 1971), there was a distinctly less rapid early height growth pattern for our plots. Thus, the following equations were developed[1] and utilized in this system:

$$H_D = (S_I)(10)^{\left\{b_1\left[\frac{1}{A_p} - \frac{1}{I}\right] + b_2\left[\left(\frac{1}{A_p}\right)^2 - \left(\frac{1}{I}\right)^2\right] + b_3\left[\left(\frac{1}{A_p}\right)^3 - \left(\frac{1}{I}\right)^3\right] + b_4\left[\left(\frac{1}{A_p}\right)^4 - \left(\frac{1}{I}\right)^4\right]\right\}}$$

and

$$S_I = (H_D)(10)^{\left\{b_1\left[\frac{1}{I} - \frac{1}{A_p}\right] + b_2\left[\left(\frac{1}{I}\right)^2 - \left(\frac{1}{A_p}\right)^2\right] + b_3\left[\left(\frac{1}{I}\right)^3 - \left(\frac{1}{A_p}\right)\right] + b_4\left[\left(\frac{1}{I}\right)^4 - \left(\frac{1}{A_p}\right)^4\right]\right\}}$$

where

$b_1 = -\ 21.0977$
$b_2 = 316.282$
$b_3 = -2443.85$
$b_4 = 6318.86$

In this paper the reference age is set at a plantation age of 25 years. The computer routines associated with the system allow flexibility in defining index age. Yield tables for an index age of 50 years, for example, can be produced. This system and the associated computer program are designed to facilitate substitution of site index equations. We expect that certain users may elect to obtain the routines and insert an equation for their own situation.

Diameter Distributions

The three parameter Weibull function (Bailey and Dell 1973) was adopted as a model for the distribution of diameters. The cumulative distribution function (c.d.f.) and the probability density function (p.d.f.) for the Weibull distribution, where x is a specified d.b.h. value and a, b, and c are the parameters to be estimated, are,

---

[1] Popham, T. W., D. F. Feduccia, T. R. Dell, W. F. Mann, Jr. and T. E. Campbell. Site index of planted loblolly on cutover sites in the West Gulf. U.S. Dep. Agric. For. Serv. Exp. Stn., New Orleans, La. (In preparation.)

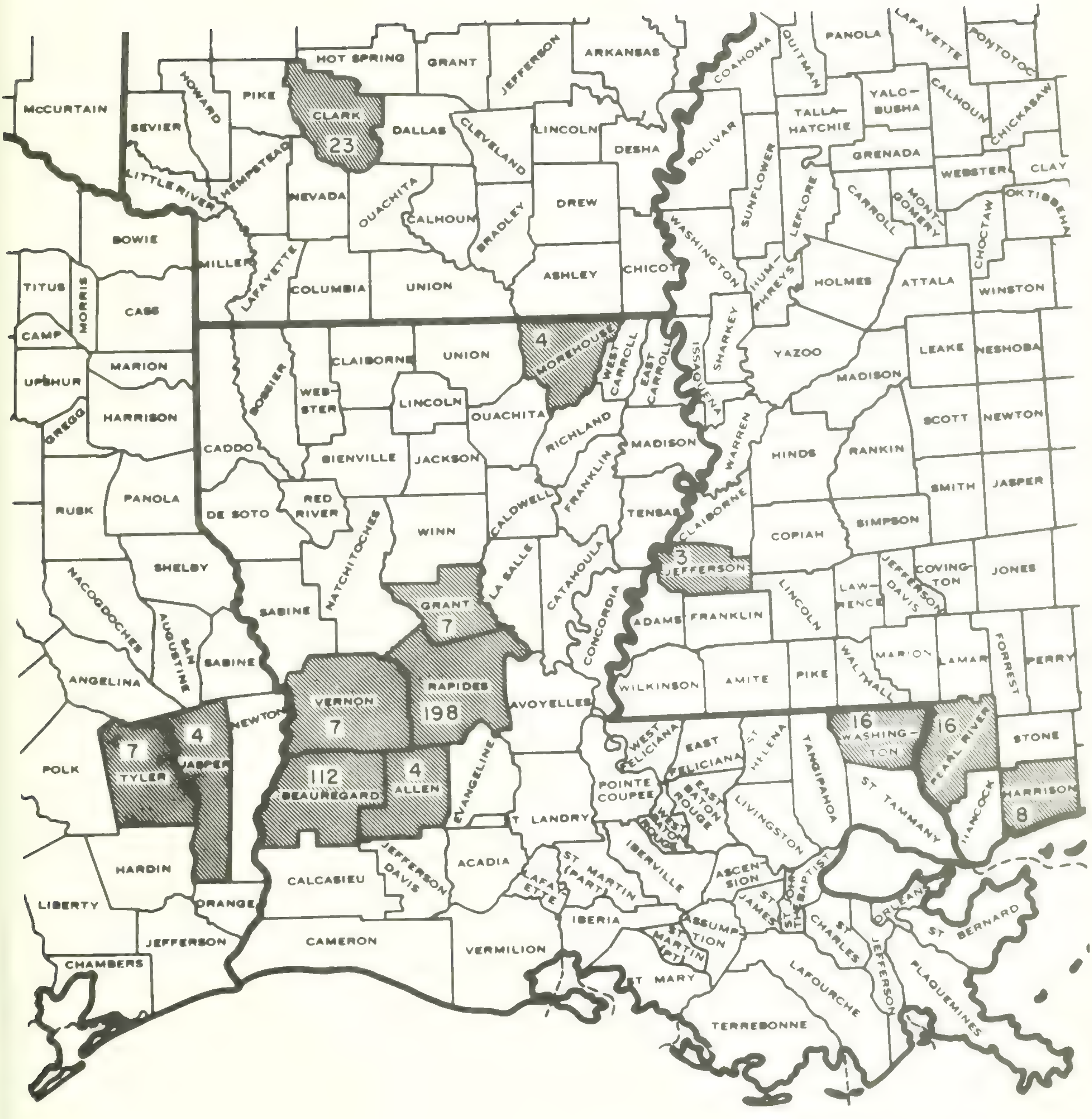

Figure 1.—*Geographic location of 409 plot observations.*

Table 1.—*Distribution of observations by plantation age and planting density*

Age class	Planting density range (trees per acre)							Totals
	≤ 250	251-500	501-750	751-1000	1001-1250	1251-1500	≥ 1500	
Years	*Number*							
3- 7	8	4	4	15	—	—	—	31
8-12	—	3	4	38	16	—	—	61
13-17	—	50	34	19	46	—	—	149
18-22	—	35	23	14	29	20	6	127
23-27	—	9	3	7	3	3	—	25
28-32	—	4	—	—	—	—	—	4
33-45	—	12	—	—	—	—	—	12
Totals	8	117	68	93	94	23	6	409

Table 2.—*Distribution of observations by plantation age and site index*

Age class	Site index class (age 25)													Totals
	≤ 22	23-27	28-32	33-37	38-42	43-47	48-52	53-57	58-62	63-67	68-72	73-77	≤ 78	
Years	*Number*													
3- 7	—	—	—	—	1	—	4	1	4	2	—	2	17	31
8-12	3	2	1	—	2	—	4	17	8	11	3	6	4	61
13-17	—	—	—	4	1	4	4	34	66	30	4	2	—	149
18-22	—	—	—	—	—	1	17	41	40	22	6	—	—	127
23-27	—	—	—	—	1	1	5	10	7	1	—	—	—	25
28-32	—	—	—	—	—	—	—	1	2	1	—	—	—	4
33-45	—	—	—	—	—	—	—	1	8	3	—	—	—	12
Totals	3	2	1	4	5	6	34	105	135	70	13	10	21	409

Table 3.—*Distribution of observations by planting density and site index*

Planting density range	Site index class (age 25)													Totals
	≤ 22	23-27	28-32	33-37	38-42	43-47	48-52	53-57	58-62	63-67	68-72	73-77	≥ 77	
No. of trees	*Number*													
≤ 250	—	—	—	—	—	—	—	—	—	—	—	—	8	8
251- 500	—	—	—	3	1	2	4	26	38	30	5	3	5	117
501- 750	—	—	—	—	—	1	2	19	26	12	—	2	6	68
751-1000	3	1	1	—	4	2	11	20	24	16	4	5	2	93
1001-1250	—	1	—	1	—	1	3	32	42	10	4	—	—	94
1251-1500	—	—	—	—	—	—	8	8	5	2	—	—	—	23
≥ 1500	—	—	—	—	—	—	6	—	—	—	—	—	—	6
Totals	3	2	1	4	5	6	34	105	135	70	13	10	21	409

c.d.f.:

$$F(x) = 1 - \exp\left\{-\left(\frac{x-a}{b}\right)^{c}\right\}, \text{ for } \quad a \leq x < \infty$$

$$= 0, \text{ otherwise}$$

p.d.f.:

$$f(x) = \frac{c}{b}\left(\frac{x-a}{b}\right)^{c-1} \exp\left\{-\left[\frac{x-a}{b}\right]^{c}\right\}, \text{ for}$$

$$a \leq x < \infty$$

$$= 0, \text{ otherwise.}$$

In general for this distribution $b > 0$ and $c > 0$ and for the application to the distribution of d.b.h. $a \geq 0$ is specified.

For each of the 409 plots, counts by one-inch d.b.h. classes on a plot basis were used to obtain fitted estimates of the three parameters. The routine FITTER provided by Bailey (1974) was employed. These estimates of the plot parameters were then used as dependent variables for developing the following multiple regression equations to predict the diameter distribution parameters as functions of H_D, T_s, and A_p.

$$a = 0.13391 - 0.076245 \log^{*} (H_D) + 2.3569 \log (A_p) - 0.70442 \log (T_s)$$

$$R^2 = 0.13,\ S_{y \cdot x} = 1.8002,\ \bar{Y} = 0.95,\ S_y^2 = 2.0135$$

$$a + b = 2.14570 + 8.1415 \log (H_D) + 2.1264 \log (A_p) - 4.13600 \log (T_s)$$

$$R^2 - 0.90,\ S_{y \cdot x} = 0.5045,\ \bar{Y} = 6.87,\ S_y^2 = 4.9730$$

$$c = 2.69350 + 5.3594 \log (H_D) - 5.1274 \log (A_p) - 0.53123 \log (T_s)$$

$$R^2 = 0.15,\ S_{y \cdot x} = 1.3317,\ \bar{Y} = 3.86,\ S_y^2 = 1.5482$$

The equations for the a and c parameters account for little of the variation. The a, or location parameter, expresses the smallest d.b.h. that could be encountered and the c parameter relates to the shape of the distribution. Estimates of these parameters vary greatly depending on the occurrence of small trees on the sample plot. On plots having the same site, age, and essentially the same density the extent to which weaker trees have been eliminated by competition or fire can vary greatly, which contributes to the difficulty of predicting the location and shape parameters.

Despite the inherent variability, the system of equations adequately defines the diameter distribution trends. Observed and predicted basal areas for the 409 plot observations had a simple correlation of +0.93 and the deviations expressed as a percent of the observed value averaged only 0.6 percent under prediction. Of the 409 observations, 257 had predictions that were within ±15 percent of the observed value. The predictions were made on the basis that T_s was known along with H_D and A_p.

Height-Diameter Relationships

This component predicts the total height of a tree (H_i), given its d.b.h. (D_i) and information on H_D, A_p, T_s, and DMAX. The latter variable is the midpoint of the largest diameter class containing at least one tree per acre as defined by the Weibull c.d.f. and T_s. The model employed was the one used by Smalley and Bailey (1974).

The data set for the following equation involved 3,787 individual height-diameter pairs.

$$\log (H_D/H_i) = -0.032876 + (1/D_i - 1/\text{DMAX}) \{1.9930 + 2.5047 A_p T_s (10^{-5}) + 0.0043249 T_s/A_p - 1.0360 \log (T_s/A_p) - 0.026038 \log (H_D/A_p)\}$$

$$R^2 = 0.70,\ S_{y \cdot x}^2 = 0.0015,\ \bar{Y} = 0.0317,\ S_y^2 = 0.0051.$$

For certain combinations of the arguments the equation predicts H_i values under 4.5 feet. When this happens the height estimate is set at 5 feet by the computer routines used to implement this system of yield predictions.

When the equation was rearranged to predict H_i and applied to the trees from which the coefficients were derived, the average value of the deviation (predicted - observed) was −0.12 feet, and 93 percent of the variation about mean height was explained.

Crown Ratio-Diameter Relationships

The ratio of living crown length to total height of the tree expressed as a percentage (CR) is a variable of interest in both silvicultural and mensurational considerations. A component was added in this system to predict the CR_i of a tree of a given D_i growing in a stand with specified values for H_D, A_p, T_s, and the three Weibull parameters of the diameter distribution.

The prediction of CR_i was built upon the following specifications:

(1) $0 < CR_i < 100$

(2) When D_i is equal to the expected value of the diameters ($\bar{D}$), then CR_i must equal the average crown ratio of all trees ($\overline{CR}$)

(3) A monotonic relationship exists such that an increase in the D_i value is associated with an increase in the predicted CR_i.

The related equations are:

$$CR_i = 100 \left[1 - \exp \left\{ \left(\frac{D_i}{\bar{D}} \right)^{\lambda} \ln \left(1 - \frac{\overline{CR}}{100} \right) \right\} \right]$$

where $\overline{CR} = 248.63 - 35.872 \log (H_D) - 43.565 \log (A_p) - 33.424 \log (T_s)$

and

$$\lambda = -5.6919 + 2.2974 \log (H_D) + 0.16988 \log (A_p) + 0.77763 \log (T_s).$$

$\bar{D} = a + b\Gamma(c^{-1} + 1)$ with $\Gamma(z)$ defined as the gamma function $\int_0^{\infty} t^{z-1} e^{-t}\, dt$ and a, b, c are the Weibull parameters of the diameter distribution.

---

* Logarithms to the base 10 and e are denoted respectively by log and *ln*.

The equation for $\overline{CR}$ was based upon a regression fitting with 65 plot observations and had the following related statistics:

$R^2 = 0.824$, $S^2_{y \cdot x} = 6.16$, $\bar{Y} = 37.39$, and
$S^2_{y} = 33.41$.

The coefficients for the equation to predict λ were obtained from a regression that used data from 1,259 trees. With early ages and poor sites the equation predicts negative λ values, so the computer routines are arranged to set λ at zero if it is predicted to be negative.

Volume-Defining Functions

In this system for estimating the volume in a tree an appropriate taper equation is defined and integrated between two points. The taper model was taken from Bennett and others (1978). In their work, separate taper equations for inside and outside bark predictions are defined by two sets of coefficients. Total height and the diameter outside bark at breast height are required for defining the taper equation of a given tree. However, we found in fitting their general model for trees of different crown ratio classes, a pattern of change occurred in some of the coefficients. Thus, given the CR of a tree, one should be able to obtain a refined taper equation for the tree.

To use the technique so that the taper function formulation was not severely complicated, we established three classes of CR values and developed separate sets of inside and outside bark taper function coefficients for each of these classes. The six sets of coefficients are given below and are based on data from 100 felled trees. These trees were deliberately selected to cover a wide range of total height, d.b.h., and crown ratio combinations. The sample included d.b.h.'s from 2 to 18 inches.

For the three classes of increasing crown ratio we had 188, 290, and 302 upper stem measurements for both inside and outside bark. These data were used to estimate coefficients (B_1 through B_4) relating to the portion of the stem above breast height.

The two coefficients in the taper model that relate to the prediction of inside bark diameter at breast height (G1 and G2) did not differ significantly by crown ratio classes and the overall estimates based on 100 trees were adopted. Coefficients concerning the taper function below breast height (ETA) for inside and outside bark situations were fitted separately for each crown ratio group. There were 62, 103, and 113 observations for the groups in order of increasing CR. For the outside bark situation the use of the G1 and G2 coefficients of 0.0 and 1.0 simply reproduces the d.b.h. outside bark. This was done to facilitate general utility of computer routines for both inside and outside bark situations.

The results of using the sets of taper curves were compared with 13 previously published volume equations for loblolly plantation trees. In each case the taper curves were used to predict volumes for the specifications and the range of tree sizes in the published work. Taper-based volumes tended to agree with equations given by Coile and Schumacher (1964) and by Bailey and Clutter (1970). The taper curve for the > 50 crown ratio group followed the volumes predicted by Schmitt and Bower (1970) more closely than the other two crown ratio groups, which was expected since these authors were dealing with a 7-year-old plantation of a 10x10 foot spacing. The taper-based tree volume predictions proved to be persistently higher

OUTSIDE BARK

Coefficient	CR < 36	36 ≤ CR ≤ 50	CR > 50
B1	21.9012	14.1180	9.6108
B2	0.130381	1.164817	−0.556774
B3	0.059713	− 0.015343	0.062742
B4	−15.31340	−12.35060	−4.23910
ETA	− 0.10105	− 0.11065	−0.12297
G1	0.0	0.0	0.0
G2	1.0	1.0	1.0

INSIDE BARK

Coefficient	CR < 36	36 ≤ CR ≤ 50	CR > 50
B1	16.5261	9.5731	6.2789
B2	− 0.150774	1.153531	−0.567733
B3	0.089512	− 0.012421	0.077350
B4	− 9.85254	− 7.88853	−1.69543
ETA	− 0.10287	− 0.10378	−0.10370
G1	− 0.46206	− 0.46206	−0.46206
G2	0.93157	0.93157	0.93157

than predictions given by Hasness and Lenhart (1972) for old fields in the interior West Gulf. The best agreement of the taper-based volumes with a published set of equations was with Smalley and Bower (1968).

In the taper equations there was a trend toward predicting greater volume as the crown ratio decreased for a given d.b.h. and total height. It seems reasonable that lower crown ratios would be associated with less drastic taper and generally more volume.

Survival

The system of equations given thus far allows predictions of detailed stand information by diameter classes if one is given T_s, A_p, and S_I. Computer routines are available to implement these predictions and were used in the development of tables contained in Appendix 1. Certain users of this system may not be able to specify T_s, however, and would rather substitute an estimate of T_s based upon a specified T_p and other information including A_p and perhaps S_I or H_D. We encourage users of this system to develop survival functions based on their experience, but we provide two survival functions in the computer routines that might be used.

Plots of this study were initially placed so as to avoid areas of poor survival and heavy damage by destructive agents. Thus, the survival function fitted to these data provides nearly ideal survival patterns. Our equation is,

$$\log (T_p/T_s) = A_p \{0.013480 \log (T_p) + 0.00060783\ H_D - 0.0084124 \sqrt{H_D}\}.$$

$$R^2 = 0.66,\ S^2_{y\cdot x} = 0.018058,\ \bar{Y} = 0.1792,\ S^2_y = 0.020627.$$

This is the model used by Smalley and Bailey (1974). Our regression fitting was based on 409 plot observations.

Tables of yields based on this survival response utilizing S_I, A_p, and T_p are given in Appendix 2. The computer routines for our system also provide an option to use the survival function of Coile and Schumacher (1964):

$$\log (T_s) = \log (T_p) + [2.1346 - 1.1103 \log (T_p) - 0.1384]\ \frac{A_p}{100}.$$

The two functions give similar predictions of survival with the major difference being that our equation includes S_I indirectly by including H_D. In the rest of this paper we will use only our survival function. In the companion paper (Dell and others 1979), which deals with slash pine yields, predictions were presented separately for the two different survival functions because of obviously large differences.

Applications

Yields of unthinned plantations can be forecast if one specifies the S_I, A_p, and a factor that expresses stand density. The density factor can be in terms of T_s or T_p. When the number of trees planted is specified, a prediction of survival is needed. This necessitates the presentation of two sets of tables.

The tables in Appendix 1 are based on S_I, A_p, and T_s. Site index changes from 40 through 70 by 10-foot intervals. Within each site index group, tables are presented for each of three ages. Finally, within each S_I and A_p combination there are tables corresponding to six levels of T_s. For each S_I, tables for the following combinations are given.

A_p	T_s					
10	400	500	600	800	1,000	1,300
20	300	400	500	700	900	1,100
30	200	300	400	500	600	800

Appendix 2 provides tables of yield where T_p is the density argument and the survival function is based on our plots. Site index is fixed at 40 through 70 in steps of 10 feet; T_p at 400, 600, 800, 1,000, 1,200, and 1,500 trees per acre; and A_p at 10, 15, 20, 25, and 30 years. The order of presentation of the tables, in which A_p changes most rapidly, facilitates viewing the plantation development through time for a given site and planting density.

After each table are estimates for such variables as the arithmetic mean d.b.h., the diameter corresponding to the tree of average basal area (quadratic mean diameter), and the corresponding site index for a base age 50. Also given in each table is an estimate by diameter class of the crown ratio or crown length as a percentage of total tree height. The coefficient, lambda, used in this prediction is listed.

Volume yield estimates, on an acre basis, were established as follows:

1. Estimate the number of trees per acre in each one-inch diameter class using predicted Weibull parameters and T_s.
2. Use midpoint diameter for each class to estimate total height and crown ratio.
3. Compute volume of the midpoint tree using appropriate specifications and taper curve as determined by variables above.
4. Multiply volume in the midpoint tree of the class by number of trees per acre in the class.
5. Sum across the diameter classes.

Projections of stand and stocking data are risky beyond the following limits: (1) ages 10 to 30, (2) sites 40 to 70, and (3) planting densities of 250 to 1,500 stems per acre. Relationships outside these ranges are not well defined due to the limited data base, as shown in tables 1, 2, and 3, (p. 4).

Trends

The following discussion of trends is limited to data predicted on the basis of the ideal survival. Figures 2 to 7 show trends for a planting density of 800 stems per acre, or about a 6- by 9-foot spacing, for sites 40 through 70 feet. Trends related to other circumstances can be obtained from the tables or by use of the computer routines.

Survival

On all sites, survival percentage decreases as age increases (fig. 2). At age 10, survival declines with decreasing site index. However, because of intensified competition on the better sites with advancing age, survival by 25 years is highest on the poorest sites (sites 40 and 50). Survival percentage on the poorest sites is similar by age 30.

Total and merchantable yields

Cubic-foot yields (o.b.) per acre for the entire stem of all trees (total yield) and trees 5 inches d.b.h. and larger to o.b. top of 4 inches (merchantable yield) increase directly with site index (figs. 3 and 4). The culmination of yield, due to the onset of mortality from suppression, does not occur by age 30.

Basal area

Basal area of all trees increases directly with site (fig. 5). Culmination occurs at age 26 on site 70 and age 30 on site 60. For sites 40 and 50, culmination does not occur by age 30.

Quadratic mean diameter

A 10-foot increase in site index results in an average gain of 0.6 inch in mean stand diameter at age 10, increasing to 0.7 inch by 30 years (fig. 6). After age 20, diameter increase tends to be linear. However, to evaluate the effects of site, age, and initial planting density, diameter distribution is more useful than mean diameter.

Mean crown ratio

The proportion of the bole with live crown declines with age and increasing site index (fig. 7). A mean crown ratio of 35 percent occurs 7 years earlier on site 70 than on site 50.

Validation and Extensions

Each of the equations presented here was evaluated by summarizing trends in deviations between predicted and observed values for the observations upon which they were based. Also, graphs were developed to insure that the predictions were reasonable. These checks were reassuring, but comprehensive validation must be based on independent data. Assistance in compiling such data has been offered by cooperating organizations, and results will be available in the future.

We did accomplish some evaluation of the total and merchantable outside bark volume predictions. Of the 409 observations, 214 involved outside bark, upper stem measurements on standing sample trees that allowed the determination of volume yields for each observation by height accumulation (Lohrey and Dell 1969) and did not utilize the taper curves. The 214 plots covered a considerable range in site index (36 - 80), planting densities (306 - 1390), and ages (10 - 45).

The volumes computed directly with the sample tree data are referred to as observed yields to contrast them with predicted yields from the system of equations. Predictions were made for the case that T_s is known and also for the case that T_p is known. For each situation, the correlation of observed and predicted values was computed as was the mean percent deviation, which is the average of the 100 (predicted - observed)/observed, values. The following summary indicates that the overall system, including the taper curve component, produces reasonably close estimates.

Variable	r	Mean Percent Deviation
Total volume, o.b. given T_s	+0.92	+2.1
Merchantable volume, o.b. given T_s	+0.90	—3.9
Total volume, o.b. given T_p	+0.91	—2.1
Merchantable volume, o.b. given T_p	+0.90	—5.6

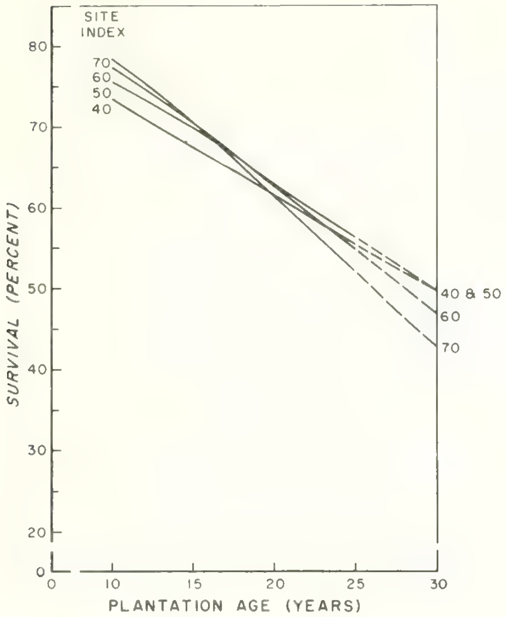

Figure 2.—*Percent survival by site index classes from age 10 to 30 years.*

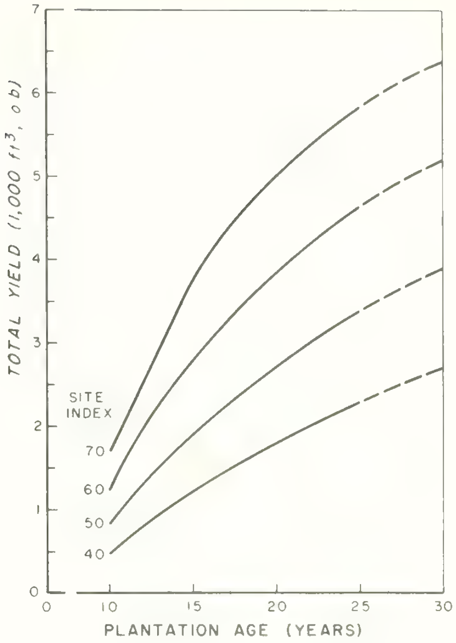

Figure 3.—*Total yield per acre by site index classes of all trees from age 10 to 30 years.*

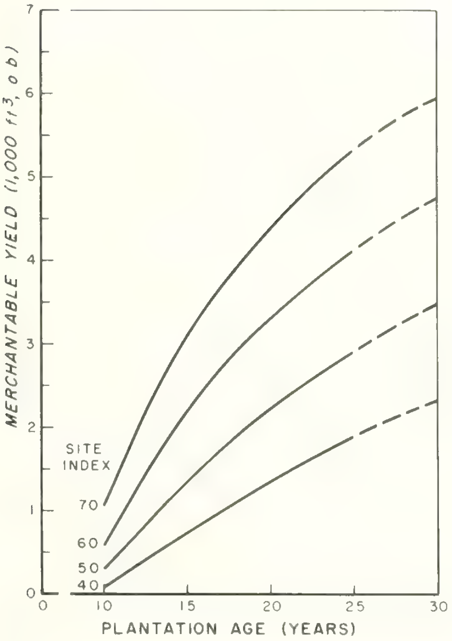

Figure 4.—*Merchantable yield per acre by site index classes of trees over 4 inches d.b.h. to 4-inch top (o.b.) from age 10 to 30 years.*

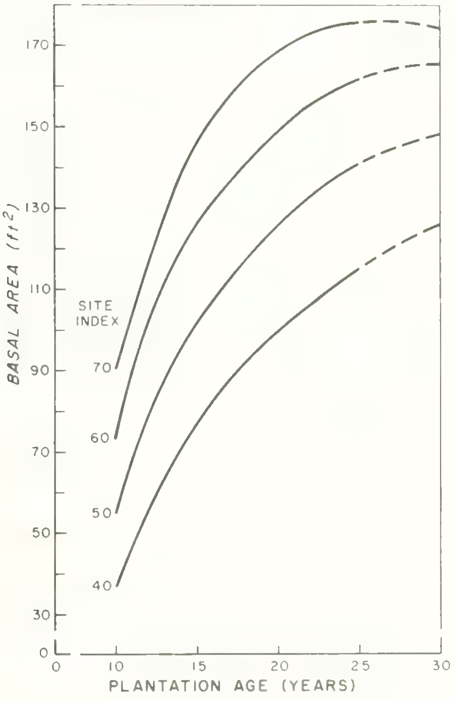

Figure 5.—*Total basal area per acre by site index classes from age 10 to 30 years.*

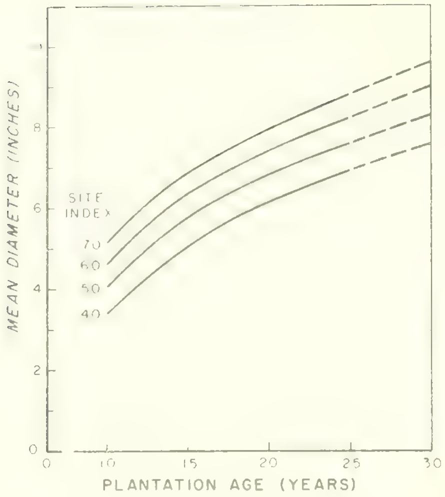

Figure 6.—*Average stand diameters by site index classes from age 10 to 30 years.*

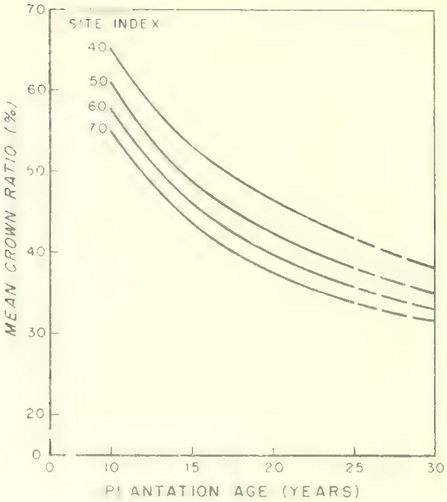

Figure 7.—*Mean crown ratio by site index classes from age 10 to 30 years.*

The equations of this system could be used with modifications and extensions of the existing computer routines to facilitate future work to predict yields: (1) with other limits of merchantability and stump height than presented here, (2) in metric units, (3) on the basis of weight, and (4) with multiproduct processing. The system is to be the foundation on which components for predicting results with thinning will be developed from currently available data.

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APPENDIX I

Yield Tables Given Site Index, Age, and Number of Surviving Stems

YIELDS GIVEN T_S —

A_P 10

S_I 40

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
10	21	1	5	.0	71	7	0	0						
		2	41	.9	71	14	10	5						
		3	104	5.1	71	17	60	35						
		4	132	11.5	71	19	139	99						
		5	87	11.9	71	21	150	105	133	94	122	87	97	68
		6	27	5.3	71	22	68	43	61	45	59	43	52	38
		7	4	1.1	71	23	14	10	13	10	12	9	12	9
			400	35.8			441	297	207	149	193	139	161	115

ARITH. MEAN DBH= 3.9 . QUADRATIC MEAN DBH= 4.0 . WEIBULL PARAMETERS A= .6 , B= 3.71 , C= 3.26
MEAN CROWN RATIO= 70.7 . LAMBDA= .000
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES GROUND TO TIP O.B.	I.B.	2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
10	21	1	10	.1	67	7	0	0						
		2	76	1.7	67	14	18	9						
		3	164	8.1	67	18	98	60						
		4	162	14.1	67	20	177	118						
		5	74	10.1	67	21	127	89	113	80	104	74	83	58
		6	13	2.6	67	22	33	24	29	22	28	21	25	18
		7	1	.3	67	23	4	3	3	2	3	2	3	2
			500	36.8			457	303	145	104	135	97	111	78

ARITH. MEAN DBH= 3.5 . QUADRATIC MEAN DBH= 3.7 . WEIBULL PARAMETERS A= .5 , B= 3.38 , C= 3.21
MEAN CROWN RATIO= 67.5 . LAMBDA= .000
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES GROUND TO TIP O.B.	I.B.	2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
10	21	1	20	.1	65	8	1	0						
		2	124	2.7	65	15	31	16						
		3	227	11.1	65	18	155	83						
		4	172	15.0	65	20	168	125						
		5	52	7.1	65	22	92	65	82	58	75	54	60	42
		6	5	1.0	65	23	13	9	12	9	11	8	10	7
			600	37.0			460	298	94	67	86	62	70	49

ARITH. MEAN DBH= 3.2 . QUADRATIC MEAN DBH= 3.4 . WEIBULL PARAMETERS A= .4 , B= 3.11 , C= 3.17
MEAN CROWN RATIO= 64.8 . LAMBDA= .000
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

YIELDS GIVEN T_S —

A_P 10

S_I 40

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                                                         ------------------------CUBIC FOOT VOLUME------------------------
GROWING                                                   ALL TREES       5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET,
SEASONS  AV.              STEMS                            GROUND         FOR O.B. TOPS OF --
 SINCE   D+C    DBH       PER      BASAL     CR     AV.    TO TIP          2 INCHES             3 INCHES              4 INCHES
  EST.   HT.              ACRE     AREA             HT.   O.B.    I.B.    O.B.    I.B.        O.B.    I.B.         O.B.    I.B.

  Yrs     Ft     In        No       Ft²      Pct    Ft    ---------------------------------Ft³---------------------------------


  10      21      1        57        .3      61      8       2       1
                  2       263       5.7      51     15      66      34
                  3       329      16.1      61     19     204     126
                  4       135      11.8      61     21     152     102
                  5        16       2.2      61     23      29      21       26      19          24      17           19      13
                          ----    ------                 -----   -----    -----   -----       -----   -----        -----   -----
                          800      36.2                    453     284       26      19          24      17           19      13

        ARITH. MEAN DBH=  2.7 ,      QUADRATIC MEAN DBH=  2.9 ,      WEIBULL PARAMETERS A=  .3 ,  B=  2.68 ,  C= 3.10
                                           MEAN CROWN PATIO= 60.6 ,      LAMBDA=  .000
                                         CORRESPONDING SITE INDEX FOR BASE AGE 50= 58



  10      21      1       128        .7      57      8       6       1
                  2       445       9.7      57     15     112      58
                  3       356      17.5      57     19     220     136
                  4        69       6.0      57     21      78      52
                  5         2        .3      57     23       4       3        3       2           3       2            2       2
                          ----    ------                 -----   -----    -----   -----       -----   -----        -----   -----
                         1000      34.2                    420     250        3       2           3       2            2       2

        ARITH. MEAN DBH=  2.4 ,      QUADRATIC MEAN DBH=  2.5 ,      WEIBULL PARAMETERS A=  .3 ,  B=  2.34 ,  C= 3.05
                                           MEAN CROWN RATIO= 57.4 ,      LAMBDA=  .000
                                         CORRESPONDING SITE INDEX FOR BASE AGE 50= 58



  10      21      1       335       1.8      54      7      13       3
                  2       713      15.6      54     15     180      92
                  3       242      11.9      54     20     155      96
                  4        10        .9      54     23      12       8
                          ----    ------                 -----   -----    -----   -----       -----   -----        -----   -----
                         1300      30.1                    360     199        0       0           0       0            0       0

        ARITH. MEAN DBH=  1.9 ,      QUADRATIC MEAN DBH=  2.0 ,      WEIBULL PARAMETERS A=  .2 ,  B=  1.95 ,  C= 2.99
                                           MEAN CROWN RATIO= 53.6 ,      LAMBDA=  .000
                                         CORRESPONDING SITE INDEX FOR BASE AGE 50= 58
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YIELDS GIVEN T_S —

A_P 20

S_I 40

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --: 2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
20	35	2	2	.0	53	15	1	0						
		3	12	.6	53	22	8	5						
		4	28	2.4	53	26	37	25						
		5	45	6.1	53	29	97	70	88	64	79	57	60	43
		6	57	11.2	53	32	188	140	172	129	163	122	143	106
		7	56	15.0	54	33	256	194	236	181	229	175	213	163
		8	47	16.4	54	35	293	227	272	213	267	208	255	199
		9	30	13.3	54	36	242	190	226	179	223	177	217	172
		10	15	8.2	54	37	154	122	144	115	142	114	139	112
		11	6	4.0	54	38	76	62	72	58	71	58	70	57
		12	2	1.6	54	38	31	25	29	24	29	23	28	23
			300	78.7			1383	1060	1239	963	1203	934	1125	875

ARITH. MEAN DBH= 6.7 . QUADRATIC MEAN DBH= 6.9 . WEIBULL PARAMETERS A= 1.3 . B= 5.95 . C= 3.01
MEAN CROWN RATIO= 53.6 . LAMBDA= .016
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
20	35	2	5	.1	45	16	1	1						
		3	22	1.1	47	22	14	9						
		4	48	4.2	48	27	63	44						
		5	72	9.8	49	30	160	119	146	109	133	99	90	65
		6	84	16.5	49	32	286	219	265	205	253	195	221	169
		7	74	19.8	50	34	362	285	339	268	330	261	309	244
		8	52	18.2	50	35	343	274	322	259	317	255	306	245
		9	28	12.4	51	36	226	178	211	167	208	165	202	160
		10	11	6.0	51	37	113	90	105	85	104	84	102	82
		11	3	2.0	52	38	38	31	36	29	36	29	35	29
		12	1	.8	52	38	15	12	14	12	14	12	14	12
			400	90.8			1621	1262	1438	1134	1395	1100	1279	1006

ARITH. MEAN DBH= 6.2 . QUADRATIC MEAN DBH= 6.4 . WEIBULL PARAMETERS A= 1.2 . B= 5.52 . C= 2.95
MEAN CROWN RATIO= 49.4 . LAMBDA= .113
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
20	35	2	9	.2	40	16	2	1						
		3	37	1.8	42	23	24	15						
		4	74	6.5	44	28	99	70						
		5	102	13.9	45	31	232	173	212	159	192	144	130	94
		6	107	21.0	46	33	372	286	345	267	330	255	287	221
		7	86	23.0	47	34	421	331	394	311	384	303	359	283
		8	52	18.2	48	36	350	280	330	265	325	261	313	251
		9	23	10.2	49	37	202	163	190	155	188	153	184	150
		10	8	4.4	50	38	89	73	84	69	83	69	82	67
		11	2	1.3	50	38	27	22	26	21	25	21	25	21
			500	100.4			1918	1414	1581	1247	1527	1206	1380	1087

ARITH. MEAN DBH= 5.8 . QUADRATIC MEAN DBH= 6.1 . WEIBULL PARAMETERS A= 1.2 . B= 5.19 . C= 2.90
MEAN CROWN RATIO= 46.1 . LAMBDA= .189
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

YIELDS GIVEN T_S —

A_P 20

S_I 40

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
20	35	1	1	.0	28	6	0	0						
		2	23	.5	33	17	7	4						
		3	77	3.8	36	24	51	33						
		4	136	11.9	39	28	181	128						
		5	165	22.5	41	31	375	279	343	257	311	232	210	152
		6	145	28.5	43	33	504	388	468	362	447	346	390	299
		7	93	24.9	44	35	465	365	436	345	425	336	397	314
		8	43	15.0	45	36	290	232	272	219	269	216	259	208
		9	14	6.2	47	37	123	99	116	94	115	93	112	91
		10	3	1.6	48	38	33	27	32	26	31	26	31	25
			700	114.8			2029	1556	1667	1303	1598	1249	1399	1089

ARITH. MEAN DBH= 5.3 , QUADRATIC MEAN DBH= 5.5 , WEIBULL PARAMETERS A= 1.1 , B- 4.69 , C= 2.82
MEAN CROWN RATIO= 41.3 , LAMBDA= .302
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
20	35	1	2	.0	23	6	0	0						
		2	45	1.0	28	16	13	7						
		3	132	6.5	32	23	94	64						
		4	208	18.2	35	28	230	212						
		5	221	30.1	38	31	502	374	459	344	416	311	282	203
		6	165	32.4	40	33	574	441	532	412	509	394	443	341
		7	87	23.3	42	35	435	343	407	323	397	314	371	294
		8	31	10.8	44	36	209	167	196	153	194	156	186	150
		9	8	3.5	45	37	70	57	66	54	65	53	64	52
		10	1	.5	46	38	11	9	11	9	10	9	10	8
			900	126.3			2198	1674	1671	1300	1591	1237	1356	1048

ARITH. MEAN DBH= 4.8 , QUADRATIC MEAN DBH= 5.1 , WEIBULL PARAMETERS A= 1.0 , B= 4.31 , C= 2.76
MEAN CROWN RATIO= 37.6 , LAMBDA= .387
CORRESPONDING SITE INDEX FOR BASE AGE 50 58

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
20	35	1	5	.0	19	5	0	0						
		2	76	1.7	25	16	21	12						
		3	200	9.8	30	23	143	97						
		4	284	24.8	33	28	396	289						
		5	267	36.4	36	31	607	452	554	416	503	376	340	246
		6	170	33.4	38	34	604	465	561	435	536	415	466	359
		7	73	19.5	41	36	373	294	350	277	341	270	318	252
		8	21	7.3	42	37	144	116	136	110	134	108	129	104
		9	4	1.8	44	38	36	29	34	28	33	27	33	27
			1100	134.7			2324	1754	1635	1266	1547	1196	1285	988

ARITH. MEAN DBH= 4.5 , QUADRATIC MEAN DBH= 4.7 , WEIBULL PARAMETERS A= .9 , B= 4.01 , C= 2.71
MEAN CROWN RATIO= 34.7 , LAMBDA= .455
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

YIELDS GIVEN T_S —

A_P 30

S_I 40

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft^2	Pct	Ft	Ft^3							
30	44	3	3	.1	44	21	2	1						
		4	9	.8	45	27	12	8						
		5	16	2.2	46	31	36	27	33	25	30	23	20	15
		6	23	4.5	47	35	83	64	78	60	74	58	64	50
		7	28	7.5	48	37	146	115	137	109	134	106	125	99
		8	29	10.1	48	39	208	167	196	158	193	156	186	150
		9	28	12.4	49	41	266	217	252	206	250	204	244	199
		10	23	12.5	49	43	282	232	268	222	266	220	262	217
		11	17	11.2	50	44	258	214	246	205	245	204	242	201
		12	11	8.6	50	45	203	170	194	162	193	162	191	160
		13	7	6.5	50	46	155	130	148	125	147	124	147	123
		14	3	3.2	51	46	75	62	71	59	71	59	70	59
		15	2	2.5	51	47	59	49	56	47	56	47	56	47
		16	1	1.4	51	48	35	29	33	28	33	28	33	28
			200	83.5			1820	1485	1712	1406	1692	1391	1640	1348

ARITH. MEAN DBH= 8.4 . QUADRATIC MEAN DBH= 8.7 . WEIBULL PARAMETERS A= 1.9 . B= 7.30 . C= 2.72

MEAN CROWN RATIO= 48.3 . LAMBDA= .129

CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

30	44	2	1	.0	32	14	0	0						
		3	8	.4	35	23	6	4						
		4	19	1.7	37	28	25	18						
		5	31	4.2	39	33	74	55	67	51	61	46	41	30
		6	41	8.1	40	36	152	118	141	110	135	105	117	90
		7	48	12.8	42	38	255	202	240	191	234	186	218	173
		8	45	15.7	43	40	329	265	311	251	306	248	294	238
		9	39	17.2	44	42	378	308	359	294	355	291	346	283
		10	29	15.8	45	43	356	293	338	280	336	278	331	273
		11	19	12.5	46	45	294	244	280	234	279	232	276	230
		12	11	8.6	46	46	207	173	198	166	197	155	195	164
		13	6	5.5	47	46	133	111	127	107	126	107	126	106
		14	2	2.1	48	47	52	44	50	42	50	42	50	42
		15	1	1.2	48	48	31	26	29	25	29	25	29	25
			300	106.0			2292	1861	2140	1751	2108	1725	2023	1654

ARITH. MEAN DBH= 7.7 . QUADRATIC MEAN DBH= 8.1 . WEIBULL PARAMETERS A= 1.7 . B= 6.69 . C= 2.62

MEAN CROWN RATIO= 42.5 . LAMBDA= .266

CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

30	44	2	2	.0	26	15	1	0						
		3	15	.7	30	23	11	7						
		4	33	2.9	32	29	47	35						
		5	50	6.8	34	33	121	92	112	85	101	77	65	48
		6	62	12.2	36	36	230	178	214	167	204	159	177	137
		7	64	17.1	38	39	347	275	327	251	318	254	297	236
		8	59	20.6	39	41	440	354	416	337	410	332	394	319
		9	47	20.8	41	42	456	371	432	354	428	350	417	342
		10	32	17.5	42	44	400	329	381	315	378	313	372	308
		11	19	12.5	43	45	294	244	280	234	279	232	276	230
		12	10	7.9	44	46	188	157	180	151	179	150	177	149
		13	4	3.7	45	46	88	74	85	71	84	71	84	71
		14	2	2.1	46	47	52	44	50	42	50	42	50	42
		15	1	1.2	47	48	31	26	29	25	29	25	29	25
			400	126.0			2706	2186	2506	2042	2460	2005	2338	1907

ARITH. MEAN DBH= 7.2 . QUADRATIC MEAN DBH= 7.6 . WEIBULL PARAMETERS A= 1.7 . B= 6.27 . C= 2.56

MEAN CROWN RATIO= 38.3 . LAMBDA= .363

CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

YIELDS GIVEN T_S —

A_P 30

S_I 40

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
30	44	2	5	.1	22	15	1	1						
		3	24	1.2	26	24	18	12						
		4	49	4.3	29	29	70	51						
		5	71	9.7	31	34	175	134	162	124	146	112	94	69
		6	84	16.5	33	37	318	249	298	234	286	225	242	189
		7	83	22.2	35	39	450	358	425	339	414	331	386	308
		8	70	24.4	37	41	522	420	494	400	486	394	467	378
		9	51	22.5	38	43	504	411	479	392	473	388	462	378
		10	33	18.0	40	44	413	340	393	325	390	322	384	317
		11	18	11.9	41	45	279	231	266	221	264	220	261	218
		12	8	6.3	42	46	151	126	144	121	143	120	142	119
		13	3	2.8	44	47	68	57	65	55	64	54	64	54
		14	1	1.1	45	48	27	22	25	22	25	22	25	21
			500	140.9			2996	2412	2751	2233	2691	2188	2527	2051

ARITH. MEAN DBH= 6.9 . QUADRATIC MEAN DBH= 7.2 . WEIBULL PARAMETERS A= 1.6 . B= 5.93 . C= 2.51
MEAN CROWN RATIO= 35.0 . LAMBDA= .438
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

30	44	2	8	.2	19	15	2	1						
		3	35	1.7	23	23	25	17						
		4	68	5.9	26	29	97	71						
		5	94	12.8	29	34	231	177	214	165	194	149	124	91
		6	104	20.4	31	37	394	308	369	290	354	279	299	234
		7	99	26.5	33	39	536	427	507	405	494	395	460	368
		8	79	27.6	35	41	589	476	559	453	551	447	530	430
		9	54	23.9	37	43	533	435	507	415	501	411	489	401
		10	32	17.5	38	44	400	329	381	315	378	313	372	308
		11	16	10.6	40	45	248	205	236	197	235	196	232	193
		12	7	5.5	41	46	132	110	126	105	125	105	124	104
		13	3	2.8	42	47	68	57	65	55	64	54	64	54
		14	1	1.1	44	48	27	22	25	22	25	22	25	21
			600	156.3			3282	2635	2989	2422	2921	2371	2719	2204

ARITH. MEAN DBH= 6.6 . QUADRATIC MEAN DBH= 6.9 . WEIBULL PARAMETERS A= 1.5 . B= 5.66 . C= 2.46
MEAN CROWN RATIO= 32.4 . LAMBDA= .500
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

30	44	2	17	.4	16	14	4	2						
		3	64	3.1	20	23	46	31						
		4	112	9.8	23	29	160	117						
		5	143	19.5	26	34	352	269	326	250	295	226	189	139
		6	146	28.7	28	37	553	433	518	407	497	391	420	329
		7	125	33.4	30	40	690	551	653	522	636	509	592	474
		8	90	31.4	32	42	683	553	649	527	640	520	615	500
		9	55	24.3	34	43	547	447	521	427	516	423	504	413
		10	29	15.8	36	45	369	304	352	291	349	289	344	295
		11	13	8.6	38	46	205	170	195	163	194	162	192	160
		12	5	3.9	39	47	96	80	92	77	91	77	90	75
		13	1	.9	41	48	23	19	22	19	22	18	22	18
			800	179.8			3728	2976	3329	2683	3240	2615	2968	2394

ARITH. MEAN DBH= 6.1 . QUADRATIC MEAN DBH= 6.4 . WEIBULL PARAMETERS A= 1.4 . B= 5.23 . C= 2.40
MEAN CROWN RATIO= 28.2 . LAMBDA= 597
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

YIELDS GIVEN T_S —

A_P 10

S_I 50

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
10	26	1	1	.0	67	9	0	0						
		2	15	.3	57	17	4	2						
		3	56	2.7	67	21	37	23						
		4	109	9.5	67	24	135	92						
		5	123	16.8	67	25	239	169	213	153	195	140	151	107
		6	73	14.3	67	27	213	156	193	143	184	136	162	120
		7	21	5.6	67	28	85	64	78	59	75	57	71	54
		8	2	.7	67	28	11	8	10	7	9	7	9	7
			400	50.0			724	514	494	362	463	340	393	288

ARITH. MEAN DBH= 4.6 , QUADRATIC MEAN DBH= 4.8 , WEIBULL PARAMETERS A= .5 , B= 4.51 , C= 3.78
MEAN CROWN RATIO= 67.2 , LAMBDA= .000
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	I.B.	2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
10	26	1	3	.0	64	9	0	0						
		2	30	.7	54	18	9	5						
		3	97	4.8	64	22	67	42						
		4	161	14.0	64	25	206	140						
		5	142	19.4	64	26	283	202	254	183	231	166	179	126
		6	58	11.4	64	27	169	124	153	114	146	108	129	95
		7	9	2.4	64	28	36	27	33	25	32	25	30	23
			500	52.6			770	540	440	322	409	299	338	244

ARITH. MEAN DBH= 4.2 , QUADRATIC MEAN DBH= 4.4 , WEIBULL PARAMETERS A= .5 , B= 4.17 , C= 3.73
MEAN CROWN RATIO= 64.0 , LAMBDA= .000
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	I.B.	2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
10	26	1	5	.0	61	10	0	0						
		2	50	1.1	51	18	15	8						
		3	148	7.3	61	22	102	64						
		4	211	18.4	61	25	269	183						
		5	143	19.5	61	26	285	203	256	184	233	167	180	127
		6	39	7.7	61	27	114	83	103	77	98	73	87	64
		7	4	1.1	61	28	16	12	15	11	14	11	13	10
			600	55.0			801	553	374	272	345	251	280	201

ARITH. MEAN DBH= 3.9 , QUADRATIC MEAN DBH= 4.1 , WEIBULL PARAMETERS A= .4 , B= 3.90 , C= 3.69
MEAN CROWN RATIO= 61.3 , LAMBDA= .000
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

YIELDS GIVEN T_S —

A_P 10

S_I 50

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
10	26	1	15	.1	57	10	1	0						
		2	116	2.5	57	18	34	18						
		3	276	13.5	57	23	196	124						
		4	276	24.1	57	25	352	240						
		5	105	14.3	57	27	215	154	193	139	176	126	135	95
		6	12	2.4	57	28	36	26	33	24	31	23	27	20
			800	56.9			834	562	226	163	207	149	162	115

ARITH. MEAN DBH= 3.5 , QUADRATIC MEAN DBH= 3.6 , WEIBULL PARAMETERS A= .3 , B= 3.47 , C= 3.62
MEAN CROWN RATIO= 57.2 , LAMBDA= .000
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
10	26	1	35	.2	51	9	2	0						
		2	221	4.8	53	18	64	34						
		3	413	20.3	54	22	284	178						
		4	276	24.1	55	25	352	240						
		5	53	7.2	55	27	109	78	98	70	89	64	68	48
		6	2	.4	56	28	6	4	5	4	5	4	5	3
			1000	57.0			817	534	103	74	94	68	73	51

ARITH. MEAN DBH= 3.1 , QUADRATIC MEAN DBH= 3.2 , WEIBULL PARAMETERS A= .3 , B= 3.14 , C= 3.57
MEAN CROWN RATIO= 53.9 , LAMBDA= .069
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
10	26	1	93	.5	45	8	4	1						
		2	452	9.9	49	18	114	59						
		3	565	27.7	51	23	402	253						
		4	180	15.7	52	26	236	161						
		5	10	1.4	54	28	21	15	19	14	17	12	13	9
			1300	55.2			777	489	19	14	17	12	13	9

ARITH. MEAN DBH= 2.7 , QUADRATIC MEAN DBH= 2.8 , WEIBULL PARAMETERS A= .2 , B= 2.75 , C= 3.51
MEAN CROWN RATIO= 50.1 , LAMBDA= .158
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

YIELDS GIVEN T_S —

A_P 20

S_I 50

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	ALL TREES GROUND TO TIP I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
20	44	2	1	.0	40	18	0	0						
		3	5	.2	43	27	4	2						
		4	15	1.3	45	32	22	16						
		5	30	4.1	47	36	76	57	69	53	61	46	40	29
		6	47	9.2	48	39	185	144	172	135	164	129	138	107
		7	58	15.5	50	41	327	260	308	247	300	240	280	223
		8	58	20.2	51	43	424	332	398	314	390	307	372	293
		9	45	19.9	52	44	426	338	401	321	396	316	383	306
		10	26	14.2	53	45	311	250	294	238	291	236	285	230
		11	11	7.3	53	46	164	133	155	127	154	126	152	124
		12	3	2.4	54	47	55	45	52	43	52	43	51	42
		13	1	.9	55	48	22	18	21	17	21	17	21	17
			300	95.2			2016	1595	1870	1495	1829	1460	1722	1371

ARITH. MEAN DBH= 7.4 , QUADRATIC MEAN DBH= 7.6 , WEIBULL PARAMETERS A= 1.3 , B= 6.75 , C= 3.53
MEAN CROWN RATIO= 50.1 , LAMBDA= .239
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES GROUND TO TIP O.B.	ALL TREES GROUND TO TIP I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
20	44	2	1	.0	33	20	0	0						
		3	10	.5	37	28	7	5						
		4	27	2.4	40	34	41	29						
		5	52	7.1	42	37	134	101	123	93	108	82	71	51
		6	74	14.5	44	40	296	231	277	217	264	207	221	171
		7	84	22.4	46	42	483	384	455	365	443	355	413	330
		8	73	25.5	48	44	575	465	546	444	537	437	516	419
		9	47	20.8	49	45	482	394	458	377	453	372	442	363
		10	23	12.5	50	46	298	246	284	236	282	234	278	230
		11	7	4.6	51	47	106	86	101	82	100	82	98	80
		12	2	1.6	52	48	37	30	35	29	35	29	35	29
			400	111.9			2459	1971	2279	1843	2222	1738	2074	1673

ARITH. MEAN DBH= 6.9 , QUADRATIC MEAN DBH= 7.2 , WEIBULL PARAMETERS A= 1.2 , B= 6.32 , C= 3.47
MEAN CROWN RATIO= 45.9 , LAMBDA= .336
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES GROUND TO TIP O.B.	ALL TREES GROUND TO TIP I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
20	44	2	3	.1	29	20	1	1						
		3	17	.8	33	29	14	10						
		4	44	3.8	36	34	66	48						
		5	78	10.6	39	38	204	154	188	143	165	125	104	75
		6	104	20.4	42	40	416	325	389	305	371	291	310	241
		7	106	28.3	44	42	609	485	575	460	559	446	521	416
		8	81	28.3	45	44	639	516	606	492	596	485	573	465
		9	45	19.9	47	45	461	377	439	361	434	357	423	348
		10	17	9.3	48	46	220	182	210	174	209	173	205	170
		11	4	2.6	50	47	64	53	61	51	61	51	60	50
		12	1	.8	51	48	19	15	18	15	18	14	17	14
			500	125.0			2713	2166	2486	2001	2413	1944	2213	1779

ARITH. MEAN DBH= 6.6 , QUADRATIC MEAN DBH= 6.8 , WEIBULL PARAMETERS A= 1.2 , B= 5.98 , C= 3.42
MEAN CROWN RATIO= 42.7 , LAMBDA= .411
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

YIELDS GIVEN T_S —

A_P 20

S_I 50

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B
Yrs	Ft	In	No	Ft^2	Pct	Ft	Ft^3							
20	44	2	8	.2	23	21	3	2						
		3	37	1.8	28	29	30	21						
		4	87	7.6	32	35	140	105						
		5	140	19.1	35	38	372	287	345	268	311	241	184	135
		6	163	32.0	38	41	665	519	622	489	592	465	495	384
		7	138	36.9	40	43	808	644	763	611	742	595	690	552
		8	83	29.0	42	45	666	539	633	515	623	507	598	486
		9	34	15.0	44	46	355	290	338	278	334	275	326	268
		10	9	4.9	46	47	119	98	113	94	112	93	111	92
		11	1	.7	48	48	16	14	16	13	16	13	15	13
			700	147.1			3174	2519	2830	2268	2730	2189	2419	1930

ARITH. MEAN DBH= 6.0 , QUADRATIC MEAN DBH= 6.2 , WEIBULL PARAMETERS A= 1.1 , B= 5.48 , C= 3.34
MEAN CROWN RATIO= 37.8 , LAMBDA= .525
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

20	44	2	16	.3	20	21	5	3						
		3	57	3.3	25	29	55	39						
		4	144	12.6	29	35	231	174						
		5	209	28.5	32	39	566	438	525	409	473	367	279	205
		6	214	42.0	35	42	889	703	836	664	801	636	673	531
		7	152	40.6	38	44	906	723	856	687	832	668	774	620
		8	72	25.1	41	45	578	468	549	446	540	440	518	422
		9	22	9.7	43	47	234	191	223	183	220	181	215	177
		10	4	2.2	45	48	54	44	51	43	51	42	50	42
			900	164.4			3518	2783	3040	2432	2917	2334	2509	1997

ARITH. MEAN DBH= 5.6 , QUADRATIC MEAN DBH= 5.8 , WEIBULL PARAMETERS A= 1.0 , B= 5.11 , C= 3.28
MEAN CROWN RATIO= 34.1 , LAMBDA= .610
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

20	44	1	1	.0	11	6	0	0						
		2	28	.6	18	20	9	5						
		3	107	5.3	23	28	86	60						
		4	213	18.6	27	34	336	251						
		5	278	37.9	30	38	739	571	686	533	618	479	366	268
		6	251	49.3	34	41	1024	808	963	763	922	731	776	611
		7	150	40.1	37	43	878	700	829	665	806	647	750	600
		8	57	19.9	39	45	458	370	434	353	428	348	410	334
		9	13	5.7	42	47	138	113	132	108	130	107	127	104
		10	2	1.1	44	48	27	22	26	21	25	21	25	21
			1100	178.5			3695	2900	3070	2443	2929	2333	2454	1938

ARITH. MEAN DBH= 5.2 , QUADRATIC MEAN DBH= 5.4 , WEIBULL PARAMETERS A= .9 , B= 4.81 , C= 3.23
MEAN CROWN RATIO= 31.2 , LAMBDA= .678
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

YIELDS GIVEN T_S –

A_P 30

S_I 50

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
30	55	3	1	.0	33	26	1	1						
		4	4	.3	35	34	5	4						
		5	9	1.2	38	39	24	18	22	17	19	15	12	9
		6	16	3.1	40	44	69	54	65	51	61	48	51	40
		7	23	6.1	42	47	144	116	137	110	133	107	123	99
		8	28	9.8	43	49	241	196	229	187	226	184	216	177
		9	31	13.7	45	51	352	290	337	[illegible]	333	275	324	268
		10	29	15.8	46	53	423	351	406	338	402	336	396	330
		11	24	15.8	47	55	440	309	422	355	420	353	415	348
		12	17	13.4	48	56	378	318	354	307	362	306	359	303
		13	10	9.2	49	57	266	225	256	217	255	217	253	215
		14	5	5.3	50	58	157	133	151	129	151	128	150	128
		15	2	2.5	51	59	72	61	69	59	69	59	69	58
		16	1	1.4	52	60	42	36	41	35	41	35	40	34
			200	97.8			2615	2171	2499	2083	2472	[illegible]	2408	2009

ARITH. MEAN DBH= 9.1 , QUADRATIC MEAN DBH= 9.4 , WEIBULL PARAMETERS A= 1.9 , B= 8.09 , C= 3.24
MEAN CROWN RATIO= 44.9 , LAMBDA= .352
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

30	55	3	3	.1	26	28	2	2						
		4	10	.9	29	36	16	12						
		5	20	2.7	32	41	56	44	52	41	47	37	27	20
		6	32	6.3	34	45	140	111	132	105	125	100	102	81
		7	42	11.2	36	48	268	215	254	205	247	199	229	185
		8	49	17.1	38	51	435	355	415	340	408	334	391	320
		9	47	20.8	40	53	551	454	528	437	522	432	508	420
		10	40	21.8	42	54	593	493	569	474	564	471	555	463
		11	28	18.5	43	56	521	436	501	421	498	419	492	413
		12	17	13.4	44	57	384	323	369	312	368	311	364	308
		13	8	7.4	46	58	216	183	208	177	207	176	206	175
		14	3	3.2	47	59	95	81	92	79	92	78	91	78
		15	1	1.2	48	60	37	32	36	31	36	31	36	30
			300	124.6			3314	2741	3156	2622	3114	2588	3001	2493

ARITH. MEAN DBH= 8.4 , QUADRATIC MEAN DBH= 8.8 , WEIBULL PARAMETERS A= 1.7 , B= 7.49 , C= 3.14
MEAN CROWN RATIO= 39.0 , LAMBDA= .489
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

30	55	2	1	.0	17	18	0	0						
		3	6	.3	21	29	5	3						
		4	17	1.5	25	36	28	21						
		5	34	4.6	28	42	97	76	90	71	79	62	47	35
		6	51	10.0	30	45	223	177	210	168	200	159	163	129
		7	64	17.1	33	48	407	328	387	313	376	304	349	282
		8	67	23.4	35	51	594	485	568	465	559	458	536	440
		9	61	26.9	37	53	716	590	685	567	678	561	659	545
		10	46	25.1	39	54	682	567	654	546	649	541	638	532
		11	29	19.1	40	56	540	452	519	436	516	434	509	428
		12	15	11.8	42	57	339	285	326	276	325	274	322	272
		13	6	5.5	43	58	162	137	156	132	155	132	154	131
		14	2	2.1	45	59	64	54	61	52	61	52	61	52
		15	1	1.2	46	60	37	32	36	31	36	31	36	30
			400	148.8			3894	3207	3692	3057	3634	3008	3474	2876

ARITH. MEAN DBH= 8.0 , QUADRATIC MEAN DBH= 8.3 , WEIBULL PARAMETERS A= 1.6 , B= 7.06 , C= 3.08
MEAN CROWN RATIO= 34.8 , LAMBDA= .586
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

YIELDS GIVEN T_S —

A_P 30

S_I 50

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft^2	Pct	Ft	Ft^3							
30	55	2	1	.0	15	19	0	0						
		3	10	.5	19	29	8	6						
		4	27	2.4	22	37	45	34						
		5	50	6.8	25	42	143	111	133	104	116	91	70	51
		6	72	14.1	28	46	320	255	302	241	286	229	233	185
		7	88	23.5	30	49	568	459	541	438	526	426	488	395
		8	85	29.7	32	52	765	626	732	600	721	592	691	568
		9	71	31.4	35	54	851	703	817	677	808	670	790	655
		10	49	26.7	37	55	738	614	708	591	702	586	690	577
		11	28	18.5	38	57	529	443	509	428	506	426	499	420
		12	13	10.2	40	58	298	251	287	243	286	242	283	239
		13	5	4.6	42	59	137	116	132	112	132	112	131	111
		14	1	1.1	43	60	32	27	31	27	31	27	31	26
			500	169.5			4434	3645	4192	3461	4114	3401	3906	3227

ARITH. MEAN DBH= 7.6 , QUADRATIC MEAN DBH= 7.9 , WEIBULL PARAMETERS A= 1.6 , B= 6.73 , C= 3.02
MEAN CROWN RATIO= 31.6 , LAMBDA= .661
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
30	55	2	2	.0	13	19	1	0						
		3	15	.7	16	29	12	9						
		4	39	3.4	20	37	65	49						
		5	69	9.4	23	42	197	153	183	143	160	125	96	71
		6	95	18.7	26	46	422	336	398	318	378	302	308	244
		7	108	28.9	28	49	697	563	664	538	645	523	598	485
		8	101	35.3	31	52	909	744	870	713	857	703	822	674
		9	79	34.9	33	54	946	782	909	753	899	745	879	729
		10	50	27.3	35	55	766	639	737	616	732	612	720	602
		11	26	17.2	37	57	491	412	472	397	470	395	464	390
		12	11	8.6	39	58	252	213	243	205	242	204	240	203
		13	4	3.7	40	59	110	93	106	90	105	89	104	89
		14	1	1.1	42	60	32	27	31	27	31	27	31	26
			600	189.1			4900	4020	4613	3800	4519	3725	4262	3513

ARITH. MEAN DBH= 7.3 , QUADRATIC MEAN DBH= 7.6 , WEIBULL PARAMETERS A= 1.5 , B= 6.46 , C= 2.98
MEAN CROWN RATIO= 28.9 , LAMBDA= .723
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
30	55	2	5	.1	10	18	2	1						
		3	29	1.4	14	29	24	17						
		4	69	6.0	17	37	115	87						
		5	113	15.4	20	42	322	251	300	235	263	205	157	116
		6	144	28.3	23	46	640	509	604	482	573	458	467	369
		7	151	40.4	25	49	975	787	928	752	902	731	837	678
		8	126	44.0	28	52	1134	928	1085	890	1069	877	1025	841
		9	86	38.0	30	54	1030	851	990	820	979	811	956	793
		10	47	25.6	32	56	731	610	704	589	699	585	687	575
		11	21	13.9	34	57	409	345	395	333	393	332	389	328
		12	7	5.5	36	59	163	137	157	133	156	132	155	131
		13	2	1.8	38	60	56	47	54	46	53	45	53	45
			800	220.4			5601	4570	5217	4280	5087	4176	4726	3876

ARITH. MEAN DBH= 6.8 , QUADRATIC MEAN DBH= 7.1 , WEIBULL PARAMETERS A= 1.4 , B= 6.03 , C= 2.92
MEAN CROWN RATIO= 24.7 , LAMBDA= .820
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

YIELDS GIVEN T_S –

A_P 10

S_I 60

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft^2	Pct	Ft	Ft^3							
10	31	2	6	.1	64	20	2	1						
		3	30	1.5	54	25	23	14						
		4	75	6.5	64	28	104	71						
		5	117	16.0	64	30	259	186	235	170	212	153	160	114
		6	108	21.2	64	31	348	258	318	238	302	226	264	196
		7	52	13.9	64	32	232	176	214	164	207	159	193	147
		8	11	3.8	64	33	65	51	61	47	60	46	57	44
		9	1	.4	64	34	8	6	7	6	7	6	7	5
			400	63.5			1041	763	835	625	788	590	681	506

ARITH. MEAN DBH= 5.2 , QUADRATIC MEAN DBH= 5.4 , WEIBULL PARAMETERS A= .5 , B= 5.16 , C= 4.21
MEAN CROWN RATIO= 64.4 , LAMBDA= .000
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

10	31	1	1	.0	60	11	0	0						
		2	13	.3	51	21	4	2						
		3	54	2.7	61	26	42	27						
		4	121	10.6	61	29	172	119						
		5	158	21.5	61	31	359	258	325	237	293	212	220	157
		6	113	22.2	61	32	373	277	341	256	323	242	283	210
		7	36	9.6	61	33	164	125	152	116	147	113	137	105
		8	4	1.4	61	34	24	19	23	18	22	17	21	17
			500	68.2			1138	827	841	627	785	584	661	489

ARITH. MEAN DBH= 4.9 , QUADRATIC MEAN DBH= 5.0 , WEIBULL PARAMETERS A= .5 , B= 4.82 , C= 4.16
MEAN CROWN RATIO= 61.1 , LAMBDA= .017
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

10	31	1	2	.0	54	11	0	0						
		2	22	.5	56	21	7	4						
		3	86	4.2	57	26	67	43						
		4	174	15.2	58	29	248	171						
		5	192	26.2	59	31	436	314	395	288	356	258	268	190
		6	102	20.0	59	32	336	250	308	231	292	219	255	190
		7	21	5.6	60	33	96	73	89	68	86	66	80	61
		8	1	.3	60	34	6	5	6	4	6	4	5	4
			600	72.1			1196	860	798	591	740	547	608	445

ARITH. MEAN DBH= 4.6 , QUADRATIC MEAN DBH= 4.7 , WEIBULL PARAMETERS A= .4 , B= 4.55 , C= 4.12
MEAN CROWN RATIO= 58.5 , LAMBDA= .078
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

YIELDS GIVEN T_S —

A_P 10

S_I 60

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                                                        ------------------------CUBIC FOOT VOLUME------------------------
GROWING                                                 ALL TREES      5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET,
SEASONS  AV.           STEMS                             GROUND        FOR O.B. TOPS OF --
 SINCE   D+C   DBH     PER     BASAL    CR    AV.        TO TIP        2 INCHES          3 INCHES          4 INCHES
 EST.    HT.           ACRE    AREA           HT.       O.B.   I.B.   O.B.   I.B.      O.B.   I.B.      O.B.   I.B.

 Yrs     Ft    In      No      Ft²      Pct   Ft        ------------------------------Ft³-------------------------------


 10      31     1        5       .0     46    11           0      0
                2       52      1.1     50    21          14      7
                3      176      8.6     52    27         141     91
                4      286     25.0     54    30         418    288
                5      215     29.3     56    32         500    361    454    331       408    296       306    218

                6       61     12.0     57    33         206    153    189    142       179    134       156    116
                7        5      1.3     58    34          23     18     22     17        21     16        19     15
                      ----   ------                    -----  -----  -----  -----     -----  -----     -----  -----
                       800     77.4                     1302    918    665    490       608    446       481    349

    ARITH. MEAN DBH=  4.1 .    QUADRATIC MEAN DBH=  4.2 .    WEIBULL PARAMETERS A=  .3 .  B=  4.12 .  C= 4.05
                                   MEAN CROWN RATIO= 54.3 .      LAMBDA=  .175
                                 CORRESPONDING SITE INDEX FOR BASE AGE 50= 88



 10      31     1       11       .1     40    11           1      0
                2      103      2.2     46    21          28     15
                3      298     14.6     49    26         207    134
                4      377     32.9     52    29         537    369
                5      184     25.1     54    31         418    301    379    276       341    247       257    182

                6       26      5.1     55    33          88     65     81     60        76     57        67     50
                7        1       .3     57    34           5      4      4      3         4      3         4      3
                      ----   ------                    -----  -----  -----  -----     -----  -----     -----  -----
                      1000     80.3                     1284    888    464    339       421    307       328    235

    ARITH. MEAN DBH=  3.7 .    QUADRATIC MEAN DBH=  3.8 .    WEIBULL PARAMETERS A=  .3 .  B=  3.79 .  C= 4.00
                                   MEAN CROWN RATIO= 51.1 .      LAMBDA=  .251
                                 CORRESPONDING SITE INDEX FOR BASE AGE 50= 88



 10      31     1       31       .2     35     9           2      1
                2      227      5.0     42    20          60     31
                3      517     25.4     46    26         360    232
                4      424     37.0     50    30         590    419
                5       97     13.2     52    32         226    163    205    149       184    134       138     98
                6        4       .8     54    34          14     10     13     10        12      9        10      8
                      ----   ------                    -----  -----  -----  -----     -----  -----     -----  -----
                      1300     81.5                     1252    856    218    159       196    143       148    106

    ARITH. MEAN DBH=  3.3 .    QUADRATIC MEAN DBH=  3.4 .    WEIBULL PARAMETERS A=  .2 .  B=  3.40 .  C= 3.94
                                   MEAN CROWN RATIO= 47.3 .      LAMBDA=  .339
                                 CORRESPONDING SITE INDEX FOR BASE AGE 50= 88
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YIELDS GIVEN T_S —

A_P 20

S_I 60

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	------------CUBIC FOOT VOLUME------------							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	------------Ft³------------							
20	53	3	2	.1	34	32	2	1						
		4	8	.7	38	39	13	10						
		5	19	2.6	41	44	55	42	51	39	45	34	28	20
		6	35	6.9	43	47	158	125	149	118	141	112	117	92
		7	51	13.6	45	49	331	266	314	253	305	246	283	228
		8	61	21.3	47	52	551	449	525	431	517	424	495	406
		9	56	24.7	49	53	657	541	629	520	622	515	605	501
		10	39	21.3	50	54	578	481	554	463	550	459	541	451
		11	20	13.2	52	56	351	287	335	276	333	273	327	269
		12	7	5.5	53	57	150	124	144	119	143	119	141	117
		13	2	1.8	54	57	51	42	49	41	49	41	48	40
			----	------			-----	-----	-----	-----	-----	-----	-----	-----
			300	111.7			2897	2368	2750	2260	2705	2223	2585	2124

ARITH. MEAN DBH= 8.0 , QUADRATIC MEAN DBH= 8.2 , WEIBULL PARAMETERS A= 1.3 , B= 7.40 , C= 3.96
MEAN CROWN RATIO= 47.2 , LAMBDA= .421
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

20	53	2	1	.0	25	23	0	0						
		3	4	.2	29	33	4	3						
		4	15	1.3	33	40	26	20						
		5	35	4.8	37	44	102	78	94	72	82	63	51	37
		6	59	11.6	39	47	267	210	251	199	238	189	198	155
		7	79	21.1	42	50	521	419	494	400	480	388	445	359
		8	83	29.0	44	52	749	611	715	586	703	576	674	552
		9	66	29.2	46	53	774	638	741	613	733	607	713	590
		10	38	20.7	48	55	572	476	549	459	545	455	535	447
		11	15	9.9	50	56	279	234	268	225	267	224	263	221
		12	4	3.1	51	57	86	71	82	68	82	68	81	67
		13	1	.9	53	57	26	21	24	20	24	20	24	20
			----	------			-----	-----	-----	-----	-----	-----	-----	-----
			400	131.8			3406	2781	3218	2642	3154	2590	2984	2448

ARITH. MEAN DBH= 7.5 , QUADRATIC MEAN DBH= 7.8 , WEIBULL PARAMETERS A= 1.2 , B= 6.97 , C= 3.89
MEAN CROWN RATIO= 43.1 , LAMBDA= .518
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

20	53	2	1	.0	21	24	0	0						
		3	8	.4	26	34	7	5						
		4	25	2.2	30	41	45	34						
		5	54	7.4	34	45	162	127	151	119	132	103	75	55
		6	87	17.1	37	48	400	316	376	299	357	283	296	232
		7	108	28.9	39	51	724	583	687	556	667	540	619	500
		8	102	35.6	42	53	935	764	893	732	878	720	841	690
		9	70	30.9	44	54	834	688	799	662	790	655	768	636
		10	33	18.0	46	55	497	413	477	398	473	395	465	388
		11	10	6.6	48	57	189	158	182	153	181	152	178	150
		12	2	1.6	50	57	45	38	43	37	43	37	43	36
			----	------			-----	-----	-----	-----	-----	-----	-----	-----
			500	148.6			3838	3126	3608	2956	3521	2885	3285	2687

ARITH. MEAN DBH= 7.2 , QUADRATIC MEAN DBH= 7.4 , WEIBULL PARAMETERS A= 1.2 , B= 6.63 , C= 3.84
MEAN CROWN RATIO= 39.8 , LAMBDA= .593
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

YIELDS GIVEN T_S —

A_P 20

S_I 60

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME — ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
20	53	2	3	.1	17	25	1	1						
		3	18	.9	22	35	16	12						
		4	53	4.6	26	42	96	74						
		5	104	14.2	30	46	316	249	295	233	258	203	146	108
		6	150	29.5	33	49	699	559	661	530	626	503	509	404
		7	161	43.0	36	52	1096	883	1041	844	1011	819	937	758
		8	122	42.6	39	54	1136	928	1085	891	1067	876	1022	839
		9	64	28.3	41	55	774	639	742	615	734	609	714	592
		10	21	11.5	44	56	321	267	308	258	306	256	301	251
		11	4	2.6	46	57	76	63	73	61	72	61	71	60
			700	177.2			4531	3675	4205	3432	4074	3327	3700	3012

ARITH. MEAN DBH= 6.6 , QUADRATIC MEAN DBH= 6.8 , WEIBULL PARAMETERS A= 1.1 , B= 6.13 , C= 3.76
MEAN CROWN RATIO= 34.9 , LAMBDA= .707
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

20	53	2	6	.1	14	24	2	1						
		3	34	1.7	19	34	31	22						
		4	93	8.1	23	41	166	127						
		5	167	22.8	27	46	508	399	474	374	414	326	235	173
		6	216	42.4	31	49	1007	804	951	763	902	724	733	582
		7	199	53.2	34	51	1326	1073	1264	1026	1228	998	1138	924
		8	124	43.3	37	53	1137	928	1085	890	1067	876	1023	839
		9	49	21.6	40	55	593	489	568	471	562	466	546	453
		10	11	6.0	42	56	168	140	161	135	160	134	157	132
		11	1	.7	45	57	19	16	18	15	18	15	18	15
			900	199.9			4957	3999	4521	3674	4351	3539	3850	3118

ARITH. MEAN DBH= 6.2 , QUADRATIC MEAN DBH= 6.4 , WEIBULL PARAMETERS A= 1.0 , B= 5.76 , C= 3.70
MEAN CROWN RATIO= 31.3 , LAMBDA= .792
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

20	53	2	11	.2	12	24	4	2						
		3	57	2.8	17	34	51	37						
		4	142	12.4	21	41	253	193						
		5	238	32.5	25	46	724	569	675	534	590	464	335	246
		6	278	54.6	29	49	1296	1035	1224	982	1161	932	943	749
		7	221	59.1	32	52	1495	1211	1426	1159	1385	1127	1283	1044
		8	113	39.4	35	54	1049	859	1005	825	990	813	948	780
		9	34	15.0	38	56	418	345	400	332	396	329	385	319
		10	6	3.3	41	57	93	78	89	75	89	74	87	73
			1100	219.3			5383	4329	4819	3907	4611	3739	3981	3211

ARITH. MEAN DBH= 5.9 , QUADRATIC MEAN DBH= 6.0 , WEIBULL PARAMETERS A= .9 , B= 5.46 , C= 3.66
MEAN CROWN RATIO= 28.4 , LAMBDA= .860
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

YIELDS GIVEN T_S —

A_P 30

S_I 60

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --: 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
Yrs	Ft	in	No	Ft^2	Pct	Ft	Ft^3							
30	66	4	2	.2	29	41	4	3						
		5	5	.7	32	47	15	12	14	11	13	10	7	5
		6	11	2.2	34	52	54	43	51	41	48	39	39	31
		7	18	4.8	37	56	130	105	124	101	120	98	111	90
		8	25	8.7	39	59	250	206	240	198	236	195	226	186
		9	30	13.3	41	62	402	333	386	322	382	318	371	309
		10	33	18.0	42	64	566	473	545	458	541	454	531	446
		11	29	19.1	44	66	622	524	601	508	597	505	589	498
		12	22	17.3	46	67	572	485	553	470	551	468	545	464
		13	14	12.9	47	68	434	370	420	359	419	358	416	355
		14	7	7.5	48	70	259	221	251	215	250	215	249	213
		15	3	3.7	50	71	129	111	125	108	125	108	124	107
		16	1	1.4	51	72	50	42	48	41	48	41	48	41
			200	109.7			3487	2928	3358	2832	3330	2809	3256	2745

ARITH. MEAN DBH= 9.7 . QUADRATIC MEAN DBH= 10.0 . WEIBULL PARAMETERS A= 1.9 . B= 8.75 . C= 3.66
MEAN CROWN RATIO= 42.0 . LAMBDA= .534
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
30	66	3	1	.0	19	34	1	1						
		4	5	.4	23	43	9	7						
		5	12	1.6	26	49	38	30	36	28	31	25	17	12
		6	23	4.5	29	54	115	93	109	88	104	84	84	67
		7	35	9.4	31	58	258	210	247	202	240	196	219	179
		8	45	15.7	34	61	462	380	444	367	437	361	418	346
		9	51	22.5	36	63	692	575	666	555	659	549	640	533
		10	47	25.6	38	65	817	684	788	662	781	656	767	645
		11	37	24.4	40	67	804	678	777	657	773	654	762	645
		12	24	18.8	42	68	632	536	611	520	609	518	603	513
		13	13	12.0	44	70	414	352	401	342	399	341	396	339
		14	5	5.3	45	71	187	160	182	156	181	155	180	155
		15	2	2.5	47	72	87	75	85	73	84	73	84	72
			300	142.9			4516	3781	4346	3650	4298	3612	4170	3506

ARITH. MEAN DBH= 9.1 . QUADRATIC MEAN DBH= 9.3 . WEIBULL PARAMETERS A= 1.7 . B= 8.14 . C= 3.57
MEAN CROWN RATIO= 36.1 . LAMBDA= .670
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
30	66	3	3	.1	16	35	3	2						
		4	9	.8	19	44	17	13						
		5	22	3.0	22	50	71	56	66	53	58	46	31	23
		6	38	7.5	25	55	194	156	183	148	174	140	140	112
		7	55	14.7	28	58	406	331	388	317	377	308	344	282
		8	67	23.4	31	61	687	566	661	546	651	538	622	515
		9	69	30.5	33	63	941	783	908	757	898	749	876	731
		10	59	32.2	35	65	1043	875	1009	848	1001	842	984	829
		11	41	27.1	37	67	891	751	861	729	856	724	844	714
		12	25	18.1	39	68	603	513	566	498	583	496	578	491
		13	10	9.2	41	70	318	271	308	263	307	263	305	261
		14	3	3.2	43	71	112	96	109	93	109	93	108	93
		15	1	1.2	45	72	44	37	42	36	42	36	42	36
			400	170.9			5333	4450	5121	4288	5056	4235	4874	4086

ARITH. MEAN DBH= 8.6 . QUADRATIC MEAN DBH= 8.9 . WEIBULL PARAMETERS A= 1.6 . B= 7.71 . C= 3.50
MEAN CROWN RATIO= 32.0 . LAMBDA= .768
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

YIELDS GIVEN T_S –

A_P 30

S_I 60

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
30	66	3	4	.2	13	35	4	3						
		4	15	1.3	17	44	28	22						
		5	33	4.5	20	51	108	86	101	81	88	70	47	35
		6	56	11.0	23	55	285	230	270	219	256	207	207	165
		7	77	20.6	26	59	576	470	551	451	535	438	489	400
		8	91	31.8	28	62	946	780	910	752	896	741	857	710
		9	85	37.6	31	64	1175	978	1134	946	1121	936	1094	914
		10	66	36.0	33	66	1182	993	1144	963	1135	956	1116	940
		11	42	27.7	35	68	955	809	926	786	921	782	911	774
		12	21	16.5	37	69	560	475	542	461	540	459	535	455
		13	8	7.4	39	70	255	217	247	211	246	210	244	208
		14	2	2.1	41	72	76	65	74	63	73	63	73	63
			500	196.6			6150	5128	5899	4933	5811	4862	5573	4664

ARITH. MEAN DBH= 8.2 . QUADRATIC MEAN DBH= 8.5 . WEIBULL PARAMETERS A= 1.6 . B= 7.38 . C= 3.45

MEAN CROWN RATIO= 28.7 . LAMBDA= .843

CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	I.B.	2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
30	65	2	1	.0	8	22	0	0						
		3	7	.3	12	35	6	5						
		4	23	2.0	15	44	43	33						
		5	47	6.4	18	51	154	122	144	115	125	99	67	49
		6	77	15.1	21	55	392	316	372	300	352	285	284	227
		7	101	27.0	24	59	756	616	723	592	702	575	641	525
		8	110	38.4	26	62	1144	943	1100	909	1083	896	1036	858
		9	98	43.3	29	64	1354	1127	1307	1090	1292	1079	1261	1054
		10	71	38.7	31	66	1271	1068	1230	1035	1221	1028	1200	1011
		11	40	26.4	33	68	909	771	882	749	877	745	868	737
		12	18	14.1	36	69	480	407	465	395	463	394	458	390
		13	6	5.5	38	70	191	163	185	158	184	158	183	156
		14	1	1.1	40	72	38	32	37	32	37	31	36	31
			600	218.4			6738	5603	6445	5375	6336	5290	6034	5038

ARITH. MEAN DBH= 7.9 . QUADRATIC MEAN DBH= 8.2 . WEIBULL PARAMETERS A= 1.5 . B= 7.11 . C= 3.41

MEAN CROWN RATIO= 26.1 . LAMBDA= .905

CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	I.B.	2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
30	66	2	2	.0	6	21	1	0						
		3	14	.7	9	34	13	9						
		4	42	3.7	12	43	77	59						
		5	82	11.2	15	50	265	210	248	197	216	171	116	85
		6	124	24.3	18	55	631	508	599	484	566	458	458	366
		7	149	39.8	21	59	1115	909	1067	873	1035	848	946	774
		8	148	51.7	23	62	1539	1269	1480	1224	1457	1205	1394	1154
		9	117	51.7	26	64	1617	1346	1560	1302	1543	1288	1506	1258
		10	72	39.3	28	66	1289	1083	1248	1050	1239	1043	1217	1025
		11	34	22.4	31	68	773	655	750	637	746	633	738	626
		12	12	9.4	33	69	336	287	327	280	325	278	323	276
		13	3	2.8	35	70	102	88	99	86	99	85	98	85
		14	1	1.1	37	72	38	32	37	32	37	31	36	31
			800	258.1			7796	6455	7415	6165	7263	6040	6832	5680

ARITH. MEAN DBH= 7.4 . QUADRATIC MEAN DBH= 7.7 . WEIBULL PARAMETERS A= 1.4 . B= 6.68 . C= 3.34

MEAN CROWN RATIO= 21.9 . LAMBDA= 1.002

CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

YIELDS GIVEN T_S –

A_P 10

S_I 70

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	ALL TREES GROUND TO TIP I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF 2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
10	37	2	3	1	58	23	1	1						
		3	16	.8	50	29	14	9						
		4	49	4.3	61	33	77	54						
		5	95	13.0	61	35	236	172	215	158	193	141	143	102
		6	120	23.6	62	37	442	331	408	309	388	293	334	250
		7	84	22.4	63	38	427	327	397	307	385	297	356	274
		8	29	10.1	63	39	196	153	183	144	180	141	172	135
		9	4	1.8	64	40	35	28	33	26	32	26	31	25
			400	76.0			1428	1075	1236	944	1178	898	1036	786

ARITH. MEAN DBH= 5.8 , QUADRATIC MEAN DBH= 5.9 , WEIBULL PARAMETERS A= .5 , B= 5.71 , C= 4.57

MEAN CROWN RATIO= 62.0 , LAMBDA= .095

CORRESPONDING SITE INDEX FOR BASE AGE 50=102

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
10	37	2	6	.1	53	24	2	1						
		3	30	1.5	55	30	26	17						
		4	83	7.2	57	33	130	91						
		5	143	19.5	58	35	356	258	324	238	290	212	215	154
		6	145	28.5	59	37	534	400	493	373	468	354	403	302
		7	76	20.3	60	38	386	295	359	277	349	269	322	248
		8	16	5.6	61	39	108	84	101	79	99	78	95	74
		9	1	.4	62	40	9	7	8	7	8	6	8	6
			500	83.2			1551	1153	1285	974	1214	919	1043	784

ARITH. MEAN DBH= 5.4 , QUADRATIC MEAN DBH= 5.5 , WEIBULL PARAMETERS A= .5 , B= 5.37 , C= 4.52

MEAN CROWN RATIO= 58.7 , LAMBDA= .171

CORRESPONDING SITE INDEX FOR BASE AGE 50=102

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
10	37	1	1	.0	43	13	0	0						
		2	10	.2	48	25	3	2						
		3	49	2.4	52	30	43	28						
		4	126	11.0	54	34	203	141						
		5	189	25.8	56	36	481	350	438	322	392	287	290	207
		6	158	31.0	58	38	594	445	549	416	521	394	448	336
		7	59	15.8	59	39	306	234	285	220	276	214	255	196
		8	8	2.8	60	40	55	43	52	41	51	40	48	38
			600	89.0			1685	1243	1324	999	1240	935	1041	777

ARITH. MEAN DBH= 5.1 , QUADRATIC MEAN DBH= 5.2 , WEIBULL PARAMETERS A= .4 , B= 5.10 , C= 4.47

MEAN CROWN RATIO= 56.1 , LAMBDA= .232

CORRESPONDING SITE INDEX FOR BASE AGE 50=102

YIELDS GIVEN T_S —

A_P 10

S_I 70

							CUBIC FOOT VOLUME							
GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
10	37	1	2	.0	36	13	0	0						
		2	25	.5	43	25	7	4						
		3	106	5.2	47	30	80	52						
		4	231	20.2	50	34	348	250						
		5	269	36.7	53	36	684	498	624	458	558	408	412	295
		6	141	27.7	55	38	530	397	490	371	465	352	400	300
		7	25	6.7	57	39	130	99	121	93	117	90	108	83
		8	1	.3	58	40	7	5	6	5	6	5	6	5
			800	97.3			1786	1305	1241	927	1146	855	926	683

ARITH. MEAN DBH= 4.6 . QUADRATIC MEAN DBH= 4.7 . WEIBULL PARAMETERS A= .3 , B= 4.67 , C= 4.41
MEAN CROWN RATIO= 51.9 . LAMBDA= .329
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
10	37	1	4	.0	31	12	0	0						
		2	50	1.1	39	24	14	8						
		3	190	9.3	44	31	145	96						
		4	351	30.6	48	34	528	380						
		5	302	41.2	51	37	785	572	716	527	640	469	471	337
		6	95	18.7	54	38	357	268	330	250	314	237	270	202
		7	8	2.1	56	40	42	32	39	31	38	30	35	27
			1000	103.0			1871	1356	1085	808	992	736	776	566

ARITH. MEAN DBH= 4.2 . QUADRATIC MEAN DBH= 4.3 . WEIBULL PARAMETERS A= .3 , B= 4.34 , C= 4.36
MEAN CROWN RATIO= 48.7 . LAMBDA= .405
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
10	37	1	12	.1	27	10	1	0						
		2	114	2.5	35	23	39	25						
		3	366	18.0	41	29	270	177						
		4	509	44.4	46	33	752	539						
		5	263	35.9	50	36	663	499	608	462	536	405	352	255
		6	35	6.9	53	38	132	99	122	92	116	87	99	74
		7	1	.3	55	40	5	4	5	4	5	4	4	3
			1300	107.9			1862	1343	735	558	657	496	455	332

ARITH. MEAN DBH= 3.8 . QUADRATIC MEAN DBH= 3.9 . WEIBULL PARAMETERS A= .2 , B= 3.95 , C= 4.30
MEAN CROWN RATIO= 44.9 . LAMBDA= .493
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

YIELDS GIVEN T_S –

A_P 20

S_I 70

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
20	62	3	1	.0	28	38	1	1						
		4	5	.4	32	45	9	7						
		5	12	1.6	35	51	39	31	37	29	32	25	17	13
		6	26	5.1	38	55	133	106	125	100	119	95	98	77
		7	42	11.2	41	58	312	253	298	243	289	235	267	217
		8	57	19.9	44	60	579	476	555	458	546	450	522	431
		9	62	27.4	46	62	830	689	798	665	790	658	767	639
		10	50	27.3	48	64	857	717	826	694	819	688	805	676
		11	30	19.8	50	65	635	535	613	518	610	515	601	508
		12	12	9.4	51	66	293	242	281	234	280	237	276	230
		13	3	2.8	53	67	88	74	85	71	85	71	84	70
			300	125.0			3776	3131	3618	3012	3570	2970	3437	2861

ARITH. MEAN DBH= 8.6 , QUADRATIC MEAN DBH= 8.8 , WEIBULL PARAMETERS A= 1.3 , B= 7.95 , C= 4.32
MEAN CROWN RATIO= 44.8 , LAMBDA= .575
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
20	62	3	2	.1	24	39	2	1						
		4	9	.8	28	46	17	13						
		5	23	3.1	32	52	77	61	72	57	62	49	33	24
		6	45	8.8	35	55	229	185	217	176	206	166	166	133
		7	69	18.4	38	58	513	416	489	399	474	387	439	357
		8	84	29.3	40	60	853	701	818	675	804	664	769	635
		9	79	34.9	43	62	1058	878	1017	848	1006	839	977	814
		10	54	29.5	45	64	926	775	892	750	885	743	869	730
		11	26	17.2	47	65	550	463	531	449	528	446	521	440
		12	8	6.3	49	66	205	174	198	169	197	168	196	166
		13	1	.9	51	67	29	25	28	24	28	24	28	23
			400	149.3			4459	3692	4262	3547	4190	3486	3998	3322

ARITH. MEAN DBH= 8.1 , QUADRATIC MEAN DBH= 8.3 , WEIBULL PARAMETERS A= 1.2 , B= 7.52 , C= 4.25
MEAN CROWN RATIO= 40.7 , LAMBDA= .672
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
20	62	3	4	.2	21	40	4	3						
		4	15	1.3	25	47	29	23						
		5	37	5.0	29	52	123	98	115	92	100	80	53	39
		6	68	13.4	32	56	351	283	333	270	315	255	254	204
		7	98	26.2	35	59	733	598	702	574	681	558	622	509
		8	111	38.7	38	61	1144	940	1097	906	1078	890	1031	851
		9	90	39.8	41	62	1205	1000	1159	966	1146	955	1113	928
		10	52	28.4	43	64	891	746	859	722	852	716	837	703
		11	20	13.2	46	65	423	357	409	345	406	343	401	339
		12	4	3.1	48	66	103	87	99	84	99	84	98	83
		13	1	.9	50	67	31	26	30	25	30	25	29	25
			500	170.2			5037	4161	4803	3984	4707	3906	4438	3681

ARITH. MEAN DBH= 7.7 , QUADRATIC MEAN DBH= 7.9 , WEIBULL PARAMETERS A= 1.2 , B= 7.18 , C= 4.20
MEAN CROWN RATIO= 37.4 , LAMBDA= .747
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

YIELDS GIVEN T_S –

A_P 20

S_I 70

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
20	62	2	1	.0	12	29	0	0						
		3	10	.5	17	40	10	7						
		4	33	2.9	21	48	65	51						
		5	75	10.2	25	53	253	201	237	189	206	164	110	81
		6	125	24.5	29	57	654	528	621	503	587	476	474	380
		7	159	42.5	32	59	1189	970	1138	932	1105	905	1009	826
		8	149	52.0	35	62	1550	1278	1490	1232	1467	1214	1403	1162
		9	97	42.9	38	63	1316	1093	1267	1056	1253	1045	1217	1014
		10	40	21.8	41	65	695	582	670	563	665	559	653	549
		11	10	6.6	44	66	21	181	207	175	206	174	203	172
		12	1	.8	46	67	26	22	25	21	25	21	25	21
			700	204.7			5973	4913	5655	4671	5514	4558	5094	4205

ARITH. MEAN DBH= 7.1 , QUADRATIC MEAN DBH= 7.3 , WEIBULL PARAMETERS A= 1.1 , B= 6.68 , C= 4.12
MEAN CROWN RATIO= 32.5 , LAMBDA= .861
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

20	62	2	3	.1	10	28	1	1						
		3	19	.9	15	40	19	14						
		4	59	5.1	19	48	117	91						
		5	124	16.9	23	53	418	333	391	313	340	271	181	133
		6	192	37.7	26	57	1005	811	954	773	902	732	728	583
		7	216	57.7	30	60	1638	337	1568	1285	1522	1248	1390	1139
		8	170	59.3	33	62	1768	1458	1700	1406	1674	1385	1601	1326
		9	87	38.4	36	64	1197	995	1152	961	1139	951	1106	923
		10	26	14.2	39	66	458	384	442	371	438	368	430	362
		11	4	2.6	42	67	87	73	84	71	84	71	82	70
			900	233.1			6708	5497	6291	5180	6099	5026	5518	4536

ARITH. MEAN DBH= 6.7 , QUADRATIC MEAN DBH= 6.9 , WEIBULL PARAMETERS A= 1.0 , B= 6.31 , C= 4.06
MEAN CROWN RATIO= 28.9 , LAMBDA= .946
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

20	62	2	5	.1	9	27	2	1						
		3	31	1.5	13	39	30	22						
		4	93	8.1	17	47	182	141						
		5	185	25.2	21	53	624	496	584	467	507	404	270	199
		6	262	51.4	25	57	1372	1107	1301	1055	1231	998	993	796
		7	263	70.3	28	60	1994	1628	1910	1564	1853	1519	1692	1387
		8	174	60.7	32	62	1810	1492	1740	1439	1713	1417	1639	1357
		9	70	30.9	35	64	967	805	934	779	923	771	901	753
		10	15	8.2	38	66	264	221	255	214	253	212	248	209
		11	2	1.3	41	67	43	37	42	36	42	35	41	35
			1100	257.9			7298	5950	6766	5554	6522	5356	5784	4736

ARITH. MEAN DBH= 6.4 , QUADRATIC MEAN DBH= 6.5 , WEIBULL PARAMETERS A= .9 , B= 6.01 , C= 4.02
MEAN CROWN RATIO= 26.0 , LAMBDA= 1.013
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

YIELDS GIVEN T_S —

A_P 30

S_I 70

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
30	77	4	1	.1	23	47	2	2						
		5	3	.4	26	55	10	8	10	8	8	7	4	3
		6	7	1.4	29	61	39	31	37	30	35	28	27	22
		7	13	3.5	32	66	107	87	102	84	99	82	90	74
		8	21	7.3	35	69	239	198	230	191	227	188	217	180
		9	28	12.4	37	72	426	356	412	345	407	341	395	331
		10	33	18.0	39	75	650	547	629	531	624	527	612	517
		11	32	21.1	41	77	786	666	763	648	758	644	748	636
		12	27	21.2	43	78	803	684	780	666	776	663	769	656
		13	19	17.5	45	80	681	583	662	568	660	566	655	562
		14	10	10.7	46	81	422	362	410	353	409	352	407	350
		15	5	6.1	48	82	245	211	239	206	238	206	237	205
		16	1	1.4	50	83	56	49	55	48	55	48	55	47
			----	------			-----	-----	-----	-----	-----	-----	-----	-----
			200	121.1			4466	3784	4329	3678	4296	3652	4216	3583

ARITH. MEAN DBH= 10.3 . QUADRATIC MEAN DBH= 10.5 . WEIBULL PARAMETERS A= 1.9 . B= 9.30 . C= 4.02
MEAN CROWN RATIO= 39.6 . LAMBDA= .687
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

30	77	3	1	.0	15	39	1	1						
		4	3	.3	18	49	6	5						
		5	8	1.1	21	57	28	23	27	21	23	19	12	9
		6	16	3.1	24	62	89	73	85	69	80	66	62	50
		7	27	7.2	27	67	224	184	215	177	209	172	190	157
		8	39	13.6	30	70	449	372	433	360	426	354	407	339
		9	49	21.6	32	73	758	634	734	615	725	609	708	594
		10	50	27.3	35	75	1001	845	972	822	964	816	947	802
		11	45	29.7	37	77	1106	937	1073	911	1066	906	1052	894
		12	32	25.1	39	79	963	820	935	799	931	795	922	787
		13	18	16.6	41	80	646	552	627	538	625	536	620	532
		14	8	8.6	43	81	337	290	328	283	327	282	325	280
		15	3	3.7	45	83	149	128	145	125	145	125	144	124
		16	1	1.4	47	83	56	49	55	48	55	48	55	47
			----	------			-----	-----	-----	-----	-----	-----	-----	-----
			300	159.3			5813	4913	5629	4768	5576	4728	5444	4615

ARITH. MEAN DBH= 9.6 . QUADRATIC MEAN DBH= 9.9 . WEIBULL PARAMETERS A= 1.7 . B= 8.69 . C= 3.93
MEAN CROWN RATIO= 33.7 . LAMBDA= .824
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

30	77	3	1	.0	12	41	1	1						
		4	5	.4	15	51	10	8						
		5	14	1.9	18	58	51	40	47	38	41	33	22	16
		6	28	5.5	21	64	161	131	153	125	144	118	111	90
		7	45	12.0	24	68	378	311	363	299	352	290	321	264
		8	61	21.3	27	71	711	590	686	570	675	562	645	537
		9	71	31.4	29	74	1111	930	1076	903	1064	893	1038	872
		10	67	36.5	32	76	1357	1146	1318	1115	1308	1107	1286	1089
		11	53	35.0	34	78	1361	1159	1325	1129	1318	1124	1302	1111
		12	33	25.9	36	80	1004	856	976	834	971	830	962	822
		13	16	14.7	38	81	580	496	564	484	562	482	558	479
		14	5	5.3	41	82	213	183	207	179	207	178	206	177
		15	1	1.2	43	83	50	43	48	42	48	42	48	41
			----	------			-----	-----	-----	-----	-----	-----	-----	-----
			400	191.3			6988	5894	6763	5718	6690	5659	6499	5498

ARITH. MEAN DBH= 9.1 . QUADRATIC MEAN DBH= 9.4 . WEIBULL PARAMETERS A= 1.6 . B= 8.26 . C= 3.86
MEAN CROWN RATIO= 29.6 . LAMBDA= .921
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

YIELDS GIVEN T_S —

A_P 30

S_I 70

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
30	77	3	2	.1	10	41	2	2						
		4	9	.8	13	51	19	15						
		5	22	3.0	16	58	79	64	74	60	64	52	34	25
		6	42	8.2	19	64	241	196	229	187	216	177	167	134
		7	65	17.4	22	68	546	449	524	432	508	420	463	382
		8	84	29.3	24	71	979	812	944	785	929	773	888	740
		9	92	40.6	27	74	1440	1205	1395	1170	1379	1157	1345	1129
		10	80	43.6	29	76	1621	1368	1574	1331	1562	1321	1536	1300
		11	56	37.0	32	78	1438	1224	1400	1193	1392	1188	1376	1174
		12	31	24.3	34	80	992	852	967	832	963	828	956	822
		13	12	11.1	36	81	435	372	423	363	422	362	418	359
		14	4	4.3	39	82	171	147	166	143	166	143	165	142
		15	1	1.2	41	83	50	43	48	42	48	42	48	41
			500	221.0			8013	6749	7744	6538	7649	6463	7396	6248

ARITH. MEAN DBH= 8.7 , QUADRATIC MEAN DBH= 9.0 , WEIBULL PARAMETERS A= 1.6 , B= 7.93 , C= 3.81
MEAN CROWN RATIO= 26.3 , LAMBDA= .997
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
30	77	3	3	.1	9	41	3	2						
		4	13	1.1	12	52	27	21						
		5	32	4.4	14	59	117	94	110	88	95	76	50	37
		6	59	11.6	17	65	343	279	326	266	308	252	237	191
		7	88	23.5	20	69	748	615	719	593	697	575	634	524
		8	109	37.7	23	72	1273	1057	1229	1023	1209	007	1155	963
		9	112	49.5	25	75	1773	1485	1718	1442	1698	426	1656	1392
		10	89	48.5	28	77	1824	1540	1771	1499	1758	1488	1729	1464
		11	57	37.6	30	79	[illegible]	1261	1441	1229	1434	1223	1417	1209
		12	27	21.2	32	81	874	751	852	733	849	730	842	725
		13	10	9.2	35	82	393	340	384	333	383	332	380	330
		14	2	2.1	37	83	86	74	84	72	84	72	83	72
			600	246.6			8942	7519	8634	7278	8515	7181	8183	6907

ARITH. MEAN DBH= 8.4 , QUADRATIC MEAN DBH= 8.7 , WEIBULL PARAMETERS A= 1.5 , B= 7.66 , C= 3.77
MEAN CROWN RATIO= 23.7 , LAMBDA= 1.058
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
30	77	2	1	.0	4	25	0	0						
		3	7	.3	7	40	7	5						
		4	25	2.2	9	51	52	40						
		5	57	7.8	12	58	206	165	193	155	167	134	88	65
		6	99	19.4	15	64	568	462	540	441	510	417	394	317
		7	138	36.9	17	68	1159	952	1113	918	1079	891	983	811
		8	156	54.5	20	72	1839	1527	1775	1477	1747	1450	1669	1391
		9	140	61.9	22	75	2217	1857	2148	1803	2123	1783	2070	1740
		10	99	54.0	25	77	2029	1714	1970	1667	1956	1655	1923	1629
		11	52	34.3	27	79	1351	1151	1315	1122	1308	1116	1293	1103
		12	20	15.7	29	81	647	556	631	543	629	541	624	537
		13	5	4.6	32	82	197	170	192	166	191	166	190	165
		14	1	1.1	34	83	47	41	46	40	46	40	46	40
			800	292.6			10319	8640	9923	8332	9756	8198	9280	7798

ARITH. MEAN DBH= 8.0 , QUADRATIC MEAN DBH= 8.2 , WEIBULL PARAMETERS A= 1.4 , B= 7.23 , C= 3.70
MEAN CROWN RATIO= 19.5 , LAMBDA= 1.156
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

APPENDIX II

Yield Tables Given Site Index, Age, Number of Trees Planted, and Ideal Survival

YIELDS GIVEN T_p WITH IDEAL SURVIVAL —

T_p 400

S_I 40

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
Yrs.	Ft	In	No	Ft²	Pct	Ft	Ft³							
10	21	1	2	.0	74	6	0	0						
		2	23	.5	74	13	5	3						
		3	66	3.2	74	17	38	23						
		4	98	8.6	74	19	103	69						
		5	85	11.6	74	20	141	99	125	89	116	82	93	65
		6	39	7.7	74	21	95	69	85	63	82	60	74	54
		7	9	2.4	74	22	31	23	28	21	27	20	25	19
		8	1	.3	74	23	5	3	4	3	4	3	4	3
			323	34.3			418	289	242	176	229	165	196	141

ARITH. MEAN DBH= 4.2 , QUADRATIC MEAN DBH= 4.4 , WEIBULL PARAMETERS A= .6 , B= 4.03 , C= 3.31
PERCENT SURVIVAL= 80.7 , MEAN CROWN RATIO= 73.8 , LAMBDA= .000
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	I.B.	2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
15	30	2	4	.1	61	15	1	1						
		3	19	.9	61	21	13	8						
		4	43	3.8	61	24	53	36						
		5	66	9.0	61	27	135	97	121	88	111	80	85	60
		6	74	14.5	61	29	227	167	207	154	196	146	173	128
		7	58	15.5	61	30	246	186	226	173	219	167	205	156
		8	33	11.5	61	31	187	144	173	134	170	132	163	127
		9	12	5.3	61	32	89	69	82	65	81	64	79	62
		10	3	1.6	61	33	28	22	26	21	26	21	25	20
			312	62.3			979	730	835	635	803	610	730	553

ARITH. MEAN DBH= 5.8 , QUADRATIC MEAN DBH= 6.0 , WEIBULL PARAMETERS A= 1.0 , B= 5.34 , C= 3.27
PERCENT SURVIVAL= 78.0 , MEAN CROWN RATIO= 60.9 , LAMBDA= .000
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	I.B.	2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
20	35	2	2	.0	53	15	1	0						
		3	11	.5	53	22	8	5						
		4	27	2.4	54	26	35	24						
		5	44	6.0	54	29	95	68	86	62	78	56	59	42
		6	56	11.0	54	32	185	137	169	127	160	120	140	104
		7	57	15.2	54	33	260	197	240	194	233	179	217	166
		8	46	16.1	54	35	286	222	266	208	261	204	250	195
		9	30	13.3	54	36	242	190	226	179	223	177	217	172
		10	15	8.2	54	37	154	122	144	115	142	114	139	112
		11	6	4.0	54	38	76	62	72	58	71	58	70	57
		12	2	1.6	54	38	31	25	29	24	29	23	28	23
			296	78.2			1373	1052	1232	957	1197	931	1120	871

ARITH. MEAN DBH= 6.7 , QUADRATIC MEAN DBH= 6.9 , WEIBULL PARAMETERS A= 1.3 , B= 5.97 , C= 3.02
PERCENT SURVIVAL= 74.0 , MEAN CROWN RATIO= 53.7 , LAMBDA= .012
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

YIELDS GIVEN T_P WITH IDEAL SURVIVAL –

T_P 400

S_I 40

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
25	40	2	1	.0	43	14	0	0						
		3	8	.4	45	22	5	3						
		4	19	1.7	46	27	25	17						
		5	33	4.5	47	31	75	56	69	51	62	46	42	30
		6	43	8.4	48	34	153	118	142	110	136	105	118	91
		7	48	12.8	48	36	245	193	230	182	224	178	209	166
		8	45	15.7	49	38	316	253	298	240	294	237	283	228
		9	36	15.9	49	39	329	267	311	254	308	251	300	245
		10	24	13.1	50	40	278	228	263	217	261	215	257	212
		11	14	9.2	50	41	201	166	191	158	190	157	187	156
		12	6	4.7	51	42	100	81	94	77	94	77	93	76
		13	2	1.8	51	43	40	33	38	31	38	31	38	31
		14	1	1.1	51	43	24	20	22	19	22	19	22	18
			280	89.4			1791	1435	1658	1339	1629	1316	1549	1253

ARITH. MEAN DBH= 7.3 , QUADRATIC MEAN DBH= 7.7 , WEIBULL PARAMETERS A= 1.6 , B= 6.46 , C= 2.81
PERCENT SURVIVAL= 70.0 , MEAN CROWN RATIO= 48.5 , LAMBDA= .129
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	I.B.	2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
30	44	2	1	.0	35	14	0	0						
		3	6	.3	38	22	4	2						
		4	15	1.3	40	28	20	14						
		5	25	3.4	41	33	59	44	54	41	49	37	33	24
		6	34	6.7	42	36	126	97	117	91	112	87	97	75
		7	40	10.7	43	38	213	168	200	159	195	155	182	144
		8	40	14.0	44	40	292	235	276	223	272	220	262	212
		9	35	15.5	45	42	339	276	322	264	318	261	311	254
		10	28	15.3	46	43	344	283	327	270	324	268	319	264
		11	19	12.5	47	44	289	239	275	229	273	228	270	225
		12	11	8.6	47	45	203	170	194	162	193	162	191	[illegible]
		13	6	5.5	48	46	133	111	127	107	126	107	126	[illegible]
		14	3	3.2	49	47	78	66	75	64	75	63	74	63
		15	1	1.2	49	48	31	26	29	25	29	25	29	[illegible]
			264	98.2			2131	1731	1996	1635	1966	1613	1894	[illegible]

ARITH. MEAN DBH= 7.9 , QUADRATIC MEAN DBH= 8.3 , WEIBULL PARAMETERS A= 1.8 , B= 6.88 , C= 2.65
PERCENT SURVIVAL= 66.0 , MEAN CROWN RATIO= 44.3 , LAMBDA= .223
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

YIELDS GIVEN T_p WITH IDEAL SURVIVAL —

T_P 600

S_I 40

							CUBIC FOOT VOLUME							
GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
10	21	1	7	.0	69	7	0	0						
		2	60	1.3	69	14	14	7						
		3	138	6.8	69	18	82	50						
		4	152	13.3	69	20	166	111						
		5	81	11.0	69	21	139	98	123	88	114	81	91	64
		6	19	3.7	69	22	48	35	43	32	41	30	37	27
		7	2	.5	69	23	7	5	6	5	6	5	6	4
			459	36.7			456	306	172	125	161	116	134	95

ARITH. MEAN DBH= 3.7 , QUADRATIC MEAN DBH= 3.8 , WEIBULL PARAMETERS A= .5 , B= 3.51 , C= 3.23
PERCENT SURVIVAL= 76.5 , MEAN CROWN RATIO= 68.7 , LAMBDA= .000
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

15	30	2	11	.2	56	16	3	2						
		3	41	2.0	56	22	28	18						
		4	81	7.1	56	25	103	70						
		5	107	14.6	56	27	219	157	197	142	179	129	138	97
		6	98	19.2	56	29	300	222	274	204	260	194	229	170
		7	61	16.3	56	30	259	196	238	182	231	176	216	164
		8	25	8.7	56	31	142	109	131	102	129	100	123	96
		9	6	2.7	56	32	44	35	41	32	41	32	39	31
		10	1	.5	56	33	9	7	9	7	9	7	8	7
			431	71.4			1107	816	890	669	849	638	753	565

ARITH. MEAN DBH= 5.3 , QUADRATIC MEAN DBH= 5.5 , WEIBULL PARAMETERS A= .9 , B= 4.86 , C= 3.20
PERCENT SURVIVAL= 71.8 , MEAN CROWN RATIO= 56.2 , LAMBDA= .000
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

20	35	2	5	.1	45	16	1	1						
		3	22	1.1	47	22	14	9						
		4	48	4.2	48	27	63	44						
		5	72	9.8	49	30	160	119	146	109	133	99	90	65
		6	82	16.1	49	32	279	214	258	200	247	191	216	165
		7	74	19.8	50	34	362	285	339	258	330	261	309	244
		8	52	18.2	50	35	343	274	322	259	317	255	306	245
		9	28	12.4	51	36	226	178	211	167	208	165	202	160
		10	11	6.0	51	37	113	90	105	85	104	84	102	82
		11	3	2.0	52	38	38	31	36	29	36	29	35	29
		12	1	.8	52	38	15	12	14	12	14	12	14	12
			398	90.4			1614	1257	1431	1129	1389	1096	1274	1002

ARITH. MEAN DBH= 6.2 , QUADRATIC MEAN DBH= 6.4 , WEIBULL PARAMETERS A= 1.3 , B= 5.53 , C= 2.95
PERCENT SURVIVAL= 66.3 , MEAN CROWN RATIO= 49.4 , LAMBDA= .112
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

YIELDS GIVEN T_P WITH IDEAL SURVIVAL —

T_P 600

S_I 40

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	ALL TREES GROUND TO TIP I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
25	40	2	3	.1	36	15	1	0						
		3	14	.7	39	23	9	6						
		4	32	2.8	41	28	43	30						
		5	51	7.0	42	32	118	88	108	81	98	74	66	48
		6	63	12.4	44	35	229	177	213	165	203	158	176	136
		7	65	17.4	45	37	339	268	318	253	310	246	289	230
		8	56	19.5	46	38	393	315	371	299	365	295	352	283
		9	40	17.7	47	40	373	303	353	288	349	285	341	278
		10	24	13.1	47	41	283	232	269	222	267	220	263	217
		11	12	7.9	48	42	175	145	167	139	166	138	164	136
		12	5	3.9	49	42	87	73	83	69	83	69	82	68
		13	2	1.8	49	43	42	35	40	33	40	33	39	33
			367	104.2			2092	1672	1922	1549	1881	1518	1772	1429

ARITH. MEAN DBH= 6.9 , QUADRATIC MEAN DBH= 7.2 , WEIBULL PARAMETERS A= 1.5 , B= 6.06 , C= 2.75
PERCENT SURVIVAL= 61.2 , MEAN CROWN RATIO= 44.6 , LAMBDA= .220
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	ALL TREES GROUND TO TIP I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
30	44	2	1	.0	30	14	0	0						
		3	10	.5	33	23	7	5						
		4	24	2.1	35	29	34	25						
		5	38	5.2	37	33	90	67	83	62	75	56	50	36
		6	49	9.6	39	36	181	140	169	132	161	125	140	108
		7	53	14.2	40	39	288	228	271	216	264	210	246	196
		8	51	17.8	41	41	380	306	360	291	354	287	340	276
		9	42	18.6	43	42	407	332	386	316	382	313	373	305
		10	30	16.4	44	43	368	303	350	289	347	287	342	283
		11	19	12.5	45	45	294	244	280	234	279	232	276	230
		12	11	8.6	45	46	207	173	198	166	197	165	195	164
		13	5	4.6	46	46	111	93	106	89	105	89	105	88
		14	2	2.1	47	47	52	44	50	42	50	42	50	42
		15	1	1.2	48	48	31	26	29	25	29	25	29	25
			336	113.4			2450	1986	2282	1862	2243	1831	2146	1753

ARITH. MEAN DBH= 7.5 , QUADRATIC MEAN DBH= 7.9 , WEIBULL PARAMETERS A= 1.7 , B= 6.52 , C= 2.60
PERCENT SURVIVAL= 56.0 , MEAN CROWN RATIO= 40.8 , LAMBDA= .304
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

YIELDS GIVEN T_P WITH IDEAL SURVIVAL --

T_P 800

S_I 40

							CUBIC FOOT VOLUME							
GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No.	Ft²	Pct	Ft	Ft³							
10	21	1	19	.1	65	8	1	0						
		2	118	2.6	65	15	30	15						
		3	219	10.8	65	18	130	80						
		4	172	15.0	65	20	188	125						
		5	54	7.4	65	22	96	67	85	61	78	56	62	43
		6	6	1.2	65	23	16	11	14	10	13	10	12	8
			----	------			-----	-----	-----	-----	-----	-----	-----	-----
			588	37.0			461	298	99	71	91	66	74	52

ARITH. MEAN DBH= 3.2 , QUADRATIC MEAN DBH= 3.4 , WEIBULL PARAMETERS A= .4 , B= 3.14 , C= 3.18
PERCENT SURVIVAL= 73.5 , MEAN CROWN RATIO= 65.1 , LAMBDA= .000
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

15	30	1	1	.0	51	[illegible]	0	0						
		2	21	.5	52	17	6	3						
		3	69	3.4	52	22	48	30						
		4	124	10.8	53	26	163	111						
		5	144	19.6	53	28	303	217	274	198	248	178	189	134
		6	110	21.6	53	30	346	256	315	236	300	224	263	195
		7	54	14.4	53	31	235	178	216	165	210	161	196	149
		8	16	5.6	54	32	93	72	86	67	84	66	81	63
		9	3	1.3	54	33	23	18	21	17	21	16	20	16
			----	------			-----	-----	-----	-----	-----	-----	-----	-----
			542	77.2			1217	885	912	683	863	645	749	557

ARITH. MEAN DBH= 4.9 , QUADRATIC MEAN DBH= 5.1 , WEIBULL PARAMETERS A= .9 , B= 4.52 , C= 3.14
PERCENT SURVIVAL= 67.7 , MEAN CROWN RATIO= 52.9 , LAMBDA= .034
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

20	35	2	9	.2	40	16	2	1						
		3	35	1.7	42	23	23	15						
		4	71	6.2	44	28	95	67						
		5	100	13.6	45	31	227	169	208	156	188	141	127	92
		6	105	20.6	47	33	365	281	339	262	324	250	282	217
		7	85	22.7	48	34	416	327	389	308	379	300	355	280
		8	52	18.2	48	36	350	280	330	[illegible]	325	261	313	251
		9	24	10.6	49	37	210	170	199	162	196	160	192	156
		10	8	4.4	50	38	[illegible]	73	84	69	83	69	82	67
		11	2	1.3	50	38	27	22	26	21	25	21	25	21
			----	------			-----	-----	-----	-----	-----	-----	-----	-----
			491	99.5			1804	1405	1575	1243	1520	1202	1376	1084

ARITH. MEAN DBH= 5.8 , QUADRATIC MEAN DBH= 6.1 , WEIBULL PARAMETERS A= 1.2 , B= 5.21 , C= 2.90
PERCENT SURVIVAL= 61.4 , MEAN CROWN RATIO= 46.4 , LAMBDA= .1[illegible]
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

YIELDS GIVEN T_P WITH IDEAL SURVIVAL —

T_P 800

S_I 40

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	ALL TREES GROUND TO TIP I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
25	40	2	4	.1	32	16	1	1						
		3	22	1.1	35	23	16	11						
		4	46	4.0	37	28	61	43						
		5	69	9.4	39	32	160	120	147	110	133	100	89	65
		6	82	16.1	41	35	297	230	277	215	264	205	230	177
		7	78	20.8	42	37	407	321	382	303	372	296	347	275
		8	63	22.0	44	38	442	355	417	337	411	332	396	319
		9	42	18.6	45	40	391	318	371	303	367	300	358	292
		10	23	12.5	46	41	271	223	258	212	256	211	252	208
		11	10	6.6	47	42	146	121	139	116	138	115	137	114
		12	4	3.1	47	42	70	58	66	55	66	55	66	55
		13	1	.9	48	43	21	18	20	17	20	17	20	17
			444	115.3			2283	1819	2077	1668	2027	1631	1895	1522

ARITH. MEAN DBH= 6.6 , QUADRATIC MEAN DBH= 6.9 , WEIBULL PARAMETERS A= 1.4 , B= 5.77 , C= 2.71
PERCENT SURVIVAL= 55.5 , MEAN CROWN RATIO= 41.8 , LAMBDA= .285
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
30	44	2	2	.0	26	15	1	0						
		3	15	.7	30	23	11	7						
		4	32	2.8	32	29	46	33						
		5	50	6.8	34	33	121	92	112	85	101	77	65	48
		6	62	12.2	36	36	230	178	214	167	204	159	177	137
		7	65	17.4	38	39	353	280	332	265	323	258	301	240
		8	59	20.6	39	41	440	354	416	337	410	332	394	319
		9	46	20.3	41	42	446	363	423	347	418	343	408	334
		10	32	17.5	42	44	400	329	381	315	378	313	372	308
		11	19	12.5	43	45	294	244	280	234	279	232	276	230
		12	10	7.9	44	46	188	157	180	151	179	150	177	149
		13	4	3.7	45	46	88	74	85	71	84	71	84	71
		14	2	2.1	46	47	52	44	50	42	50	42	50	42
		15	1	1.2	47	48	31	26	29	25	29	25	29	25
			399	125.8			2701	2181	2502	2039	2455	2002	2333	1903

ARITH. MEAN DBH= 7.2 , QUADRATIC MEAN DBH= 7.6 , WEIBULL PARAMETERS A= 1.7 . B= 6.27 , C= 2.56
PERCENT SURVIVAL= 49.9 , MEAN CROWN RATIO= 38.3 , LAMBDA= .362
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

YIELDS GIVEN T_p WITH IDEAL SURVIVAL —

T_p 1000

S_I 40

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
10	21	1	37	.2	62	8	2	0						
		2	196	4.3	62	15	50	25						
		3	292	14.3	62	18	174	107						
		4	159	13.9	62	20	173	116						
		5	28	3.8	62	22	50	35	44	31	41	29	32	23
		6	1	.2	62	23	3	2	2	2	2	2	2	1
			713	36.7			452	285	46	33	43	31	34	24

ARITH. MEAN DBH= 2.9 , QUADRATIC MEAN DBH= 3.1 , WEIBULL PARAMETERS A= .4 , B= 2.85 , C= 3.13
PERCENT SURVIVAL= 71.3 , MEAN CROWN RATIO= 62.3 , LAMBDA= .000
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

15	30	1	2	.0	45	7	0	0						
		2	33	.7	48	17	8	4						
		3	103	5.1	49	23	67	43						
		4	168	14.7	50	26	214	150						
		5	174	23.7	51	28	366	262	331	239	299	216	228	162
		6	113	22.2	51	30	355	263	324	242	308	230	270	200
		7	44	11.8	52	31	192	145	176	135	171	131	159	122
		8	10	3.5	52	32	58	45	54	42	53	41	51	39
		9	1	.4	53	33	8	6	7	6	7	5	7	5
			648	82.1			1268	918	892	664	838	623	715	528

ARITH. MEAN DBH= 4.6 , QUADRATIC MEAN DBH= 4.8 , WEIBULL PARAMETERS A= .8 , B= 4.26 , C= 3.10
PERCENT SURVIVAL= 64.8 , MEAN CROWN RATIO= 50.3 , LAMBDA= .094
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

20	35	2	14	.3	37	17	3	2						
		3	51	2.5	39	23	33	21						
		4	96	8.4	42	28	128	90						
		5	125	17.0	43	31	284	211	260	195	235	176	159	115
		6	124	24.3	45	33	431	332	400	310	382	296	333	256
		7	91	24.3	46	34	445	350	417	329	406	321	380	300
		8	50	17.5	47	36	337	269	317	255	312	251	301	242
		9	20	8.8	48	37	175	142	165	135	164	133	160	130
		10	6	3.3	49	38	67	54	63	52	63	51	61	51
		11	1	.7	49	38	13	11	13	11	13	11	13	10
			578	107.1			1916	1482	1635	1287	1575	1239	1407	1104

ARITH. MEAN DBH= 5.6 , QUADRATIC MEAN DBH= 5.8 , WEIBULL PARAMETERS A= 1.1 , B= 4.97 , C= 2.86
PERCENT SURVIVAL= 57.8 , MEAN CROWN RATIO= 44.0 , LAMBDA= .238
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

YIELDS GIVEN T_P WITH IDEAL SURVIVAL –

T_P 1000

S_I 40

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME — ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
25	40	2	7	.2	29	16	2	1						
		3	30	1.5	33	23	21	15						
		4	61	5.3	35	29	87	64						
		5	87	11.9	37	32	202	151	185	139	167	125	113	81
		6	97	19.0	39	35	352	272	327	254	312	243	271	209
		7	90	24.1	41	37	469	371	441	350	429	341	401	318
		8	67	23.4	42	38	470	377	444	358	437	353	421	339
		9	42	18.6	43	40	391	318	371	303	367	300	358	292
		10	21	11.5	44	41	248	203	235	194	234	193	230	190
		11	8	5.3	46	42	117	97	111	92	111	92	109	91
		12	3	2.4	46	42	52	44	50	42	50	41	49	41
		13	1	.9	47	43	21	18	20	17	20	17	20	17
			514	123.9			2432	1931	2184	1749	2127	1705	1972	1578

ARITH. MEAN DBH= 6.3 . QUADRATIC MEAN DBH= 6.6 . WEIBULL PARAMETERS A= 1.4 . B= 5.55 . C= 2.67
PERCENT SURVIVAL= 51.4 . MEAN CROWN RATIO= 39.6 . LAMBDA= .335
CORRESPONDING SITE INUEX FOR BASE AGE 50= 58

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
30	44	2	3	.1	24	15	1	0						
		3	20	1.0	27	24	15	10						
		4	41	3.6	30	29	58	43						
		5	61	8.3	33	34	150	115	139	107	126	96	81	59
		6	74	14.5	35	37	280	219	263	206	252	198	213	167
		7	76	20.3	36	39	413	327	388	309	378	301	352	280
		8	66	23.0	38	41	492	396	465	377	458	371	441	357
		9	50	22.1	39	43	494	403	469	385	464	380	453	371
		10	33	18.0	41	44	413	340	393	325	390	322	384	317
		11	18	11.9	42	45	279	231	266	221	264	220	261	218
		12	9	7.1	43	46	169	141	162	136	161	135	160	134
		13	4	3.7	44	47	90	76	86	73	86	72	85	72
		14	1	1.1	45	48	27	22	25	22	25	22	25	21
			456	134.6			2881	2323	2656	2161	2604	2117	2455	1996

ARITH. MEAN C9H= 7.0 . QUADRATIC MEAN DBH= 7.4 . WEIBULL PARAMETERS A= 1.6 . B= 6.07 . C= 2.53
PERCENT SURVIVAL= 45.6 . MEAN CROWN RATIO= 36.4 . LAMBDA= .407
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

YIELDS GIVEN T_P WITH IDEAL SURVIVAL —

T_P 1200

S_I 40

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
10	21	1	66	.4	60	8	3	1						
		2	293	6.4	60	15	74	38						
		3	340	16.7	60	19	211	130						
		4	124	10.8	60	21	140	94						
		5	12	1.6	60	23	22	16	20	14	18	13	14	10
			----	------			-----	-----	-----	-----	-----	-----	-----	-----
			835	35.9			450	279	20	14	18	13	14	10

ARITH. MEAN DBH= 2.7 , QUADRATIC MEAN DBH= 2.8 , WEIBULL PARAMETERS A= .3 , B= 2.61 , C= 3.09
PERCENT SURVIVAL= 69.6 , MEAN CROWN RATIO= 60.0 , LAMBDA= .000
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
15	30	1	4	.0	41	8	0	0						
		2	50	1.1	44	17	12	6						
		3	141	6.9	46	23	92	59						
		4	213	18.6	48	26	271	190						
		5	194	26.5	49	29	421	312	384	266	350	260	239	172
		6	107	21.0	50	30	347	265	321	247	307	236	269	206
		7	34	9.1	51	32	152	115	140	107	136	104	126	96
		8	6	2.1	51	33	36	28	33	26	32	25	31	24
			----	------			-----	-----	-----	-----	-----	-----	-----	-----
			749	85.3			1331	975	878	666	825	625	665	498

ARITH. MEAN DBH= 4.4 , QUADRATIC MEAN DBH= 4.6 , WEIBULL PARAMETERS A= .8 , B= 4.04 , C= 3.07
PERCENT SURVIVAL= 62.4 , MEAN CROWN RATIO= 48.2 , LAMBDA= .144
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
20	35	1	1	.0	29	6	0	0						
		2	20	.4	34	17	6	3						
		3	68	3.3	37	23	44	28						
		4	122	10.6	40	28	163	115						
		5	152	20.7	41	31	345	257	316	237	286	214	194	140
		6	138	27.1	43	33	480	369	445	345	425	329	371	285
		7	93	24.9	45	34	455	358	426	336	415	328	388	306
		8	46	16.1	46	36	310	248	292	234	287	231	277	222
		9	16	7.1	47	37	140	114	132	108	131	107	128	104
		10	4	2.2	48	38	44	36	42	35	42	34	41	34
		11	1	.7	49	38	13	11	13	11	13	11	13	10
			----	------			-----	-----	-----	-----	-----	-----	-----	-----
			661	113.1			2000	1539	1666	1306	1599	1254	1412	1101

ARITH. MEAN DBH= 5.3 , QUADRATIC MEAN DBH= 5.6 , WEIBULL PARAMETERS A= 1.1 , B= 4.77 , C= 2.83
PERCENT SURVIVAL= 55.1 , MEAN CROWN RATIO= 42.1 , LAMBDA= .283
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

YIELDS GIVEN T_P WITH IDEAL SURVIVAL –

T_P 1200

S_I 40

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No.	Ft²	Pct	Ft	Ft³							
25	40	2	10	.2	27	16	3	2						
		3	39	1.9	31	24	29	20						
		4	76	6.6	33	29	109	79						
		5	105	14.3	36	33	249	186	228	172	206	155	138	100
		6	112	22.0	38	35	406	314	378	294	361	280	313	242
		7	99	26.5	39	37	516	408	485	385	472	375	441	350
		8	70	24.4	41	39	502	403	474	383	467	377	449	362
		9	41	18.1	42	40	382	311	362	296	358	293	349	285
		10	19	10.4	44	41	224	184	213	175	211	174	208	172
		11	7	4.6	45	42	102	85	97	81	97	80	96	80
		12	2	1.6	46	43	36	30	34	28	34	28	33	28
			580	130.6			2557	2022	2271	1814	2206	1762	2027	1619

ARITH. MEAN DBH= 6.1 . QUADRATIC MEAN DBH= 6.4 . WEIBULL PARAMETERS A= 1.4 , B= 5.37 , C= 2.64
PERCENT SURVIVAL= 48.3 . MEAN CROWN RATIO= 37.9 . LAMBDA= .375
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

30	44	2	5	.1	22	15	1	1						
		3	25	1.2	26	24	18	13						
		4	50	4.4	29	29	71	52						
		5	73	10.0	31	34	180	137	166	128	150	115	97	71
		6	85	16.7	33	37	322	252	302	237	289	228	245	191
		7	84	22.4	35	39	455	362	430	343	419	335	390	312
		8	71	24.8	37	41	529	426	501	405	493	399	474	384
		9	52	23.0	36	43	514	419	488	400	482	396	471	386
		10	33	18.0	40	44	413	340	393	325	390	322	384	317
		11	18	11.9	41	45	279	231	266	221	264	220	261	218
		12	8	6.3	42	46	151	126	144	121	143	120	142	119
		13	3	2.8	43	47	68	57	65	55	64	54	64	54
		14	1	1.1	44	48	27	22	25	22	25	22	25	21
			508	142.5			3028	2438	2780	2257	2719	2211	2553	2073

ARITH. MEAN DBH= 6.8 . QUADRATIC MEAN DBH= 7.2 . WEIBULL PARAMETERS A= 1.6 , B= 5.91 , C= 2.50
PERCENT SURVIVAL= 42.3 . MEAN CROWN RATIO= 34.8 . LAMBDA= .444
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

YIELDS GIVEN T_P WITH IDEAL SURVIVAL –

T_P 1500

S_I 40

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP		CUBIC FOOT VOLUME: 5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
10	21	1	135	.7	57	8	5	1						
		2	456	9.9	57	15	115	59						
		3	355	17.4	57	19	220	136						
		4	65	5.7	57	21	73	49						
		5	2	.3	57	23	4	3	3	2	3	2	2	2
			1013	34.1			418	248	3	2	3	2	2	2

ARITH. MEAN DBH= 2.4 , QUADRATIC MEAN DBH= 2.5 , WEIBULL PARAMETERS A= .3 , B= 2.32 , C= 3.05
PERCENT SURVIVAL= 67.5 , MEAN CROWN RATIO= 57.2 , LAMBDA= .000
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
15	30	1	8	.0	37	7	0	0						
		2	81	1.8	41	17	20	10						
		3	206	10.1	44	23	134	86						
		4	275	24.0	45	26	350	245						
		5	211	28.8	47	29	458	339	418	312	380	283	260	187
		6	91	17.9	48	30	295	226	273	210	262	201	229	175
		7	21	5.6	49	32	98	77	92	72	89	70	84	66
		8	2	.7	50	33	13	10	12	9	12	9	11	9
			895	88.9			1368	993	795	603	743	563	584	437

ARITH. MEAN DBH= 4.1 , QUADRATIC MEAN DBH= 4.3 , WEIBULL PARAMETERS A= .7 , B= 3.77 , C= 3.03
PERCENT SURVIVAL= 59.7 , MEAN CROWN RATIO= 45.6 , LAMBDA= .204
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
20	35	1	1	.0	25	6	0	0						
		2	31	.7	31	17	9	5						
		3	97	4.8	35	24	71	49						
		4	163	14.2	37	28	217	153						
		5	186	25.4	40	31	423	315	386	290	350	262	237	171
		6	155	30.4	41	33	539	414	500	387	478	370	416	320
		7	92	24.6	43	35	460	362	431	341	420	333	393	310
		8	39	13.6	45	36	263	210	247	199	244	196	235	188
		9	11	4.9	46	37	96	78	91	74	90	73	88	72
		10	2	1.1	47	38	22	18	21	17	21	17	20	17
			777	119.6			2100	1604	1676	1308	1603	1251	1389	1078

ARITH. MEAN DBH= 5.1 , QUADRATIC MEAN DBH= 5.3 , WEIBULL PARAMETERS A= 1.0 , B= 4.53 , C= 2.79
PERCENT SURVIVAL= 51.8 , MEAN CROWN RATIO= 39.7 , LAMBDA= .338
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

YIELDS GIVEN T_P WITH IDEAL SURVIVAL —

T_P 1500

S_I 40

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
25	40	2	14	.3	24	16	4	2						
		3	54	2.7	28	24	40	27						
		4	99	8.6	31	29	141	104						
		5	130	17.7	34	33	314	239	290	222	263	201	169	124
		6	135	26.5	36	35	490	378	456	354	435	338	378	291
		7	109	29.1	38	37	568	449	534	424	520	413	485	385
		8	72	25.1	40	39	516	414	487	393	480	388	462	373
		9	38	16.8	41	40	354	288	336	274	332	271	324	265
		10	16	8.7	43	41	189	155	179	148	178	147	175	144
		11	5	3.3	44	42	73	60	70	58	69	57	68	57
		12	1	.8	45	43	18	15	17	14	17	14	17	14
			673	139.7			2707	2131	2369	1887	2294	1829	2078	1653

ARITH. MEAN DBH= 5.9 . QUADRATIC MEAN DBH= 6.2 . WEIBULL PARAMETERS A= 1.3 . B= 5.15 . C= 2.61
PERCENT SURVIVAL= 44.9 . MEAN CROWN RATIO= 35.7 . LAMBDA= .425
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

30	44	2	7	.2	20	15	2	1						
		3	33	1.6	24	23	24	16						
		4	64	5.6	27	29	91	67						
		5	89	12.1	29	34	219	168	203	156	183	141	118	86
		6	100	19.6	32	37	379	297	355	279	340	268	288	225
		7	96	25.7	34	39	520	414	491	393	479	383	446	357
		8	77	26.9	35	41	574	463	545	441	537	435	516	419
		9	54	23.9	37	43	533	435	507	415	501	411	489	401
		10	32	17.5	39	44	400	329	381	315	378	313	372	308
		11	17	11.2	40	45	263	218	251	209	249	208	247	205
		12	7	5.5	41	46	132	110	126	105	125	105	124	104
		13	3	2.8	43	47	68	57	65	55	64	54	64	54
		14	1	1.1	44	48	27	22	25	22	25	22	25	21
			580	153.5			3232	2597	2949	2390	2881	2340	2689	2180

ARITH. MEAN DBH= 6.6 . QUADRATIC MEAN DBH= 7.0 . WEIBULL PARAMETERS A= 1.5 . B= 5.71 . C= 2.47
PERCENT SURVIVAL= 38.7 . MEAN CROWN RATIO= 32.9 . LAMBDA= .489
CORRESPONDING SITE INDEX FOR BASE AGE 50= 58

YIELDS GIVEN T_P WITH IDEAL SURVIVAL —

T_P 400

S_I 50

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
10	26	1	1	.0	70	8	0	0						
		2	9	.2	70	16	2	1						
		3	36	1.8	70	21	24	15						
		4	77	6.7	70	24	95	65						
		5	99	13.5	70	25	192	136	172	123	157	112	122	86
		6	76	14.9	70	27	221	163	201	149	191	142	169	125
		7	30	8.0	70	28	121	91	111	84	108	82	101	77
		8	5	1.7	70	28	26	20	24	19	24	18	23	18
			333	46.9			681	491	508	375	480	354	415	306

ARITH. MEAN DBH= 4.9 , QUADRATIC MEAN DBH= 5.1 , WEIBULL PARAMETERS A= .6 , B= 4.78 , C= 3.83
PERCENT SURVIVAL= 83.2 , MEAN CROWN RATIO= 69.9 , LAMBDA= .000
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	I.B.	2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
15	38	2	1	.0	54	19	0	0						
		3	9	.4	55	26	7	4						
		4	26	2.3	56	30	38	26						
		5	50	6.8	56	33	119	86	108	79	97	71	73	52
		6	71	13.9	57	35	251	187	231	174	218	164	190	142
		7	74	19.8	57	37	368	281	342	264	332	256	307	236
		8	54	18.8	58	38	358	278	334	262	327	257	313	245
		9	27	11.9	58	39	232	183	217	173	214	171	208	165
		10	8	4.4	58	40	87	70	82	66	81	65	79	64
		11	1	.7	59	41	14	11	13	10	13	10	12	10
			321	79.1			1474	1126	1327	1028	1282	994	1182	914

ARITH. MEAN DBH= 6.5 , QUADRATIC MEAN DBH= 6.7 , WEIBULL PARAMETERS A= 1.0 , B= 6.10 , C= 3.78
PERCENT SURVIVAL= 80.2 , MEAN CROWN RATIO= 57.0 , LAMBDA= .080
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	I.B.	2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
20	44	2	1	.0	40	18	0	0						
		3	5	.2	43	27	4	2						
		4	15	1.3	45	32	22	16						
		5	31	4.2	47	36	78	59	72	54	63	48	42	30
		6	48	9.4	48	39	189	147	176	138	168	131	141	109
		7	59	15.8	49	41	333	265	314	251	305	244	284	227
		8	58	20.2	51	43	424	332	398	314	390	307	372	293
		9	45	19.9	52	44	426	338	401	321	396	316	383	306
		10	26	14.2	52	45	311	250	294	238	291	236	285	230
		11	11	7.3	53	46	164	133	155	127	154	126	152	124
		12	3	2.4	54	47	55	45	52	43	52	43	51	42
		13	1	.9	55	48	22	18	21	17	21	17	21	17
			303	95.8			20[illegible]8	1605	1883	1503	1840	1468	1731	1378

ARITH. MEAN DBH= 7.4 , QUADRATIC MEAN DBH= 7.6 , WEIBULL PARAMETERS A= 1.3 , B= 6.73 , C= 3.53
PERCENT SURVIVAL= 75.7 , MEAN CROWN RATIO= 49.9 , LAMBDA= .243
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

YIELDS GIVEN T_P WITH IDEAL SURVIVAL –

T_P 400

S_I 50

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
25	50	3	3	.1	34	27	2	2						
		4	10	.9	37	34	15	11						
		5	21	2.9	39	39	56	42	52	39	45	34	28	21
		6	34	6.7	41	42	141	110	132	104	126	99	105	82
		7	45	12.0	43	45	273	218	258	207	251	202	233	187
		8	51	17.8	45	47	424	344	403	329	397	324	381	310
		9	46	20.3	46	49	506	415	483	398	477	393	465	383
		10	35	19.1	47	50	486	403	465	387	462	384	454	378
		11	22	14.5	49	51	378	315	362	303	360	302	356	298
		12	11	8.6	50	52	230	193	220	186	219	185	217	183
		13	4	3.7	51	53	96	79	92	76	91	76	90	75
		14	1	1.1	51	54	29	24	27	23	27	23	27	23
			283	107.7			2636	2156	2494	2052	2455	2022	2356	1940

ARITH. MEAN DBH= 8.1 , QUADRATIC MEAN DBH= 8.3 , WEIBULL PARAMETERS A= 1.6 , B= 7.24 , C= 3.33
PERCENT SURVIVAL= 70.7 , MEAN CROWN RATIO= 44.8 , LAMBDA= .356
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
30	55	3	2	.1	28	28	2	1						
		4	7	.6	31	35	11	8						
		5	15	2.0	34	41	42	33	39	31	35	27	21	15
		6	25	4.9	36	45	109	86	103	81	98	77	81	63
		7	35	9.4	38	48	223	179	212	171	206	166	191	154
		8	43	15.0	40	50	376	306	358	293	352	288	338	276
		9	41	18.1	41	52	473	390	453	374	448	371	436	360
		10	36	19.6	43	54	534	444	512	427	508	424	499	417
		11	27	17.8	44	56	503	421	483	406	480	404	474	398
		12	17	13.4	46	57	384	323	369	312	368	311	364	308
		13	9	8.3	47	58	243	206	234	199	233	198	231	197
		14	4	4.3	48	59	127	108	123	105	122	104	122	104
		15	1	1.2	49	60	37	32	36	31	36	31	36	30
			262	114.7			3064	2537	2922	2430	2886	2401	2793	2322

ARITH. MEAN DBH= 8.7 , QUADRATIC MEAN DBH= 9.0 , WEIBULL PARAMETERS A= 1.8 , B= 7.69 , C= 3.17
PERCENT SURVIVAL= 65.5 , MEAN CROWN RATIO= 40.9 , LAMBDA= .443
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

YIELDS GIVEN T_p WITH IDEAL SURVIVAL —

T_P 600

S_I 50

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	ALL TREES GROUND TO TIP I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
10	26	1	2	.0	65	9	0	0						
		2	25	.5	65	17	7	4						
		3	85	4.2	65	21	57	35						
		4	147	12.8	65	24	182	123						
		5	138	18.8	65	26	275	196	247	178	225	161	174	123
		6	63	12.4	65	27	183	135	166	124	158	118	140	103
		7	12	3.2	65	28	48	37	44	34	43	33	40	31
		8	1	.3	65	28	5	4	5	4	5	4	5	4
			473	52.3			757	534	462	340	431	316	359	261

ARITH. MEAN DBH= 4.3 , QUADRATIC MEAN DBH= 4.5 , WEIBULL PARAMETERS A= .5 , B= 4.26 , C= 3.75
PERCENT SURVIVAL= 78.8 , MEAN CROWN RATIO= 64.8 , LAMBDA= .000
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
15	38	2	4	.1	45	20	1	1						
		3	20	1.0	48	27	14	9						
		4	52	4.5	50	31	74	53						
		5	90	12.3	51	34	219	159	199	146	179	130	133	95
		6	111	21.8	52	36	400	299	369	278	348	262	303	226
		7	94	25.1	53	38	478	365	444	343	431	333	398	306
		8	52	18.2	54	39	352	274	329	258	322	253	308	241
		9	18	8.0	55	40	158	125	148	118	146	116	142	113
		10	3	1.6	56	41	33	27	31	25	31	25	30	24
			444	92.5			1729	1312	1520	1168	1457	1119	1314	1005

ARITH. MEAN DBH= 6.0 , QUADRATIC MEAN DBH= 6.2 , WEIBULL PARAMETERS A= .9 , B= 5.61 , C= 3.71
PERCENT SURVIVAL= 74.0 , MEAN CROWN RATIO= 52.3 , LAMBDA= .190
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
20	44	2	2	.0	33	20	1	0						
		3	10	.5	37	28	7	5						
		4	28	2.4	40	34	42	30						
		5	54	7.4	42	37	139	105	127	97	112	85	73	53
		6	77	15.1	44	40	308	240	288	226	274	215	230	178
		7	85	22.7	46	42	489	389	461	369	448	359	417	334
		8	74	25.8	47	44	583	472	553	450	545	443	523	425
		9	47	20.8	49	45	482	394	458	377	453	372	442	363
		10	22	12.0	50	46	285	235	272	225	270	224	266	220
		11	7	4.6	51	47	106	86	101	82	100	82	98	80
		12	2	1.6	52	48	37	30	35	29	35	29	35	29
			408	113.0			2479	1986	2295	1855	2237	1809	2084	1682

ARITH. MEAN DBH= 6.9 , QUADRATIC MEAN DBH= 7.1 , WEIBULL PARAMETERS A= 1.2 , B= 6.29 , C= 3.46
PERCENT SURVIVAL= 68.0 , MEAN CROWN RATIO= 45 .. , LAMBDA= .343
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

YIELDS GIVEN T_P WITH IDEAL SURVIVAL –

T_P 600

S_I 50

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
25	50	2	1	.0	25	19	0	0						
		3	6	.3	29	28	5	3						
		4	18	1.6	33	35	29	22						
		5	35	4.8	35	39	95	73	88	68	79	62	47	34
		6	53	10.4	38	43	224	176	210	165	200	157	166	130
		7	66	17.6	40	45	400	320	379	304	368	295	342	275
		8	66	23.0	42	47	549	445	522	425	513	419	493	402
		9	56	24.7	43	49	615	505	587	485	581	479	566	467
		10	38	20.7	45	50	528	437	505	420	501	417	493	410
		11	20	13.2	46	51	344	287	329	276	327	274	323	271
		12	8	6.3	48	52	167	140	160	135	159	134	158	133
		13	3	2.8	49	53	75	63	72	61	72	61	71	60
		14	1	1.1	50	54	29	25	28	24	28	24	28	24
			371	126.5			3060	2496	2880	2363	2828	2323	2687	2206

ARITH. MEAN DBH= 7.6 , QUADRATIC MEAN DBH= 7.9 , WEIBULL PARAMETERS A= 1.5 , B= 6.83 , C= 3.27
PERCENT SURVIVAL= 61.8 , MEAN CROWN RATIO= 40.9 , LAMBDA= .447
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

30	55	3	4	.2	24	29	3	2						
		4	12	1.0	27	36	20	15						
		5	24	3.3	30	41	67	52	63	49	56	44	33	24
		6	38	7.5	33	45	166	132	157	125	149	119	121	96
		7	49	13.1	35	48	311	251	296	240	288	233	267	216
		8	55	19.2	37	51	489	398	466	381	458	375	439	360
		9	52	23.0	39	53	610	503	584	483	578	478	562	465
		10	42	22.9	40	54	623	518	597	498	592	494	582	486
		11	29	19.1	42	56	540	452	519	436	516	434	509	428
		12	16	12.6	43	57	361	304	348	294	346	293	343	290
		13	8	7.4	45	58	216	183	208	177	207	176	206	175
		14	3	3.2	46	59	95	81	92	79	92	78	91	78
		15	1	1.2	47	60	37	32	36	31	36	31	36	30
			333	133.7			3538	2923	3366	2793	3318	2755	3189	2648

ARITH. MEAN DBH= 8.3 , QUADRATIC MEAN DBH= 8.6 , WEIBULL PARAMETERS A= 1.7 , B= 7.33 , C= 3.12
PERCENT SURVIVAL= 55.5 , MEAN CROWN RATIO= 37.4 , LAMBDA= .524
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

YIELDS GIVEN T_P WITH IDEAL SURVIVAL —

T_P 800

S_I 50

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	ALL TREES GROUND TO TIP I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF 2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
10	26	1	5	.0	61	10	0	0						
		2	52	1.1	61	18	15	6						
		3	152	7.5	61	22	105	66						
		4	215	18.8	61	25	274	187						
		5	142	19.4	61	26	283	202	254	183	231	166	179	126
		6	38	7.5	61	27	111	81	100	75	96	71	84	62
		7	3	.8	61	28	12	9	11	8	11	8	10	8
			607	55.0			800	553	365	266	338	245	273	196

ARITH. MEAN DBH= 3.9 , QUADRATIC MEAN DBH= 4.1 , WEIBULL PARAMETERS A= .4 , B= 3.88 , C= 3.69
PERCENT SURVIVAL= 75.9 , MEAN CROWN RATIO= 61.2 , LAMBDA= .000
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES GROUND TO TIP O.B.	ALL TREES GROUND TO TIP I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
15	38	2	8	.2	40	21	2	1						
		3	35	1.7	43	28	25	17						
		4	85	7.4	46	32	123	88						
		5	133	18.1	48	34	322	242	295	223	267	201	178	129
		6	144	28.3	50	36	533	413	497	387	474	369	411	318
		7	100	26.7	51	38	508	389	473	365	459	354	424	326
		8	43	15.0	52	39	291	227	272	214	266	209	255	200
		9	10	4.4	53	40	88	69	82	66	81	65	79	63
		10	1	.5	54	41	11	9	10	8	10	8	10	8
			559	102.4			1903	1455	1629	1263	1557	1206	1357	1044

ARITH. MEAN DBH= 5.6 , QUADRATIC MEAN DBH= 5.8 , WEIBULL PARAMETERS A= .9 , B= 5.27 , C= 3.66
PERCENT SURVIVAL= 69.9 , MEAN CROWN RATIO= 49.0 , LAMBDA= .267
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES GROUND TO TIP O.B.	ALL TREES GROUND TO TIP I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
20	44	2	3	.1	29	20	1	1						
		3	17	.8	33	29	14	10						
		4	44	3.8	36	34	66	48						
		5	79	10.8	39	38	207	156	190	145	167	127	105	76
		6	105	20.6	41	40	420	328	393	308	374	293	313	243
		7	107	28.6	43	42	615	490	580	464	564	452	526	420
		8	81	28.3	45	44	639	516	606	492	596	485	573	465
		9	45	19.9	47	45	461	377	439	361	434	357	423	348
		10	17	9.3	48	46	220	182	210	174	209	173	205	170
		11	4	2.6	50	47	64	53	61	51	61	51	60	50
		12	1	.8	51	48	19	15	18	15	18	14	17	14
			503	125.6			2726	2176	2497	2010	2423	1952	2222	1786

ARITH. MEAN DBH= 6.5 , QUADRATIC MEAN DBH= 6.8 , WEIBULL PARAMETERS A= 1.2 , B= 5.97 , C= 3.41
PERCENT SURVIVAL= 62.9 , MEAN CROWN RATIO= 42.6 , LAMBDA= .414
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

YIELDS GIVEN T_P WITH IDEAL SURVIVAL –

T_P 800

S_I 50

							CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.			2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
25	50	2	1	.0	22	19	0	0						
		3	10	.5	26	29	8	6						
		4	27	2.4	30	36	44	33						
		5	50	6.8	33	40	138	107	128	100	115	90	68	50
		6	72	14.1	35	43	304	241	286	228	274	218	223	175
		7	84	22.4	38	46	518	415	491	395	477	384	443	356
		8	80	27.9	40	48	676	550	644	526	633	517	607	495
		9	62	27.4	41	50	693	570	662	546	655	541	637	526
		10	37	20.2	43	51	523	433	500	416	496	413	488	406
		11	18	11.9	45	52	315	263	301	253	300	251	296	248
		12	6	4.7	46	53	127	107	122	103	122	103	121	102
		13	2	1.8	48	54	51	43	49	41	49	41	48	41
			----	------			-----	-----	-----	-----	-----	-----	-----	-----
			449	140.2			3397	2768	3183	2608	3121	2558	2931	2400

ARITH. MEAN DBH= 7.3 , QUADRATIC MEAN DBH= 7.6 , WEIBULL PARAMETERS A= 1.4 , B= 6.55 , C= 3.22
PERCENT SURVIVAL= 56.1 , MEAN CROWN RATIO= 38.1 , LAMBDA= .511
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

30	55	2	1	.0	17	18	0	0						
		3	6	.3	22	29	5	3						
		4	17	1.5	25	36	28	21						
		5	33	4.5	28	42	94	73	88	69	77	60	46	34
		6	50	9.8	31	45	219	174	206	164	196	156	160	126
		7	63	16.8	33	48	400	323	381	308	370	300	343	278
		8	66	23.0	35	51	585	478	559	458	551	452	528	433
		9	60	26.5	37	53	704	580	674	558	667	552	648	536
		10	46	25.1	39	54	682	567	654	546	649	541	638	532
		11	29	19.1	40	56	540	452	519	436	516	434	509	428
		12	15	11.8	42	57	339	285	326	276	325	274	322	272
		13	7	6.5	44	58	189	160	182	155	181	154	180	153
		14	2	2.1	45	59	64	54	61	52	61	52	61	52
		15	1	1.2	46	60	37	32	36	31	36	31	36	30
			----	------			-----	-----	-----	-----	-----	-----	-----	-----
			396	148.3			3886	3202	3686	3053	3629	3006	3471	2874

ARITH. MEAN DBH= 8.0 , QUADRATIC MEAN DBH= 8.3 , WEIBULL PARAMETERS A= 1.7 , B= 7.08 , C= 3.08
PERCENT SURVIVAL= 49.5 , MEAN CROWN RATIO= 35.0 , LAMBDA= .582
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

YIELDS GIVEN T_P WITH IDEAL SURVIVAL —

T_P 1000

S_I 50

GROWING SEASONS SINCE EST.	. /. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
10	26	1	11	.1	58	10	1	0						
		2	91	2.0	58	18	27	14						
		3	233	11.4	58	22	161	101						
		4	262	22.9	58	25	334	227						
		5	120	16.4	58	26	240	170	215	154	196	140	151	107
		6	18	3.5	58	27	52	39	48	35	45	34	40	30
		7	1	.3	58	28	4	3	4	3	4	3	3	3
			736	56.5			819	554	267	192	245	177	194	140

ARITH. MEAN DBH= 3.6 , QUADRATIC MEAN DBH= 3.7 , WEIBULL PARAMETERS A= .4 , B= 3.60 , C= 3.64
PERCENT SURVIVAL= 73.6 , MEAN CROWN RATIO= 58.4 , LAMBDA= .000
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

GROWING SEASONS SINCE EST.	. /. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
15	38	1	1	.0	30	9	0	0						
		2	13	.3	36	21	4	2						
		3	55	2.7	40	28	40	26						
		4	122	10.6	43	32	177	126						
		5	.77	24.1	46	35	437	329	401	304	362	273	241	175
		6	166	32.6	48	37	627	486	585	456	557	435	476	368
		7	97	25.9	49	39	527	417	495	395	482	384	450	358
		8	32	11.2	51	40	221	172	207	163	202	159	193	152
		9	5	2.2	52	41	45	35	42	33	41	33	40	32
			668	109.7			2078	1593	1730	1351	1644	1284	1400	1085

ARITH. MEAN DBH= 5.3 , QUADRATIC MEAN DBH= 5.5 , WEIBULL PARAMETERS A= .8 , B= 5.01 , C= 3.61
PERCENT SURVIVAL= 66.8 , MEAN CROWN RATIO= 46.4 , LAMBDA= .327
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

GROWING SEASONS SINCE EST.	. /. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
20	44	2	5	.1	26	21	2	1						
		3	25	1.2	31	29	20	14						
		4	62	5.4	34	35	100	75						
		5	105	14.3	37	38	275	208	253	193	222	168	140	101
		6	131	25.7	40	41	534	417	500	393	476	374	397	309
		7	123	32.9	42	43	720	574	680	545	661	530	615	492
		8	84	29.3	44	45	674	546	640	521	630	513	605	492
		9	41	18.1	46	46	428	350	407	335	403	331	393	323
		10	13	7.1	47	47	172	142	164	136	162	135	160	133
		11	3	2.0	49	48	49	41	47	39	47	39	46	38
			592	136.2			2974	2368	2691	2162	2601	2090	2356	1888

ARITH. MEAN DBH= 6.3 , QUADRATIC MEAN DBH= 6.5 , WEIBULL PARAMETERS A= 1.1 , B= 5.73 , C= 3.38
PERCENT SURVIVAL= 59.2 , MEAN CROWN RATIO= 40.2 , LAMBDA= .469
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

YIELDS GIVEN T_P WITH IDEAL SURVIVAL –

T_P 1000

S_I 50

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	ALL TREES GROUND TO TIP I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
25	50	2	2	.0	20	20	1	0						
		3	13	.6	24	29	11	8						
		4	36	3.1	28	36	59	44						
		5	65	8.9	31	40	179	139	166	130	150	117	88	65
		6	90	17.7	33	44	387	307	365	290	349	278	283	223
		7	101	27.0	36	46	623	499	590	475	573	462	533	428
		8	91	31.8	38	48	769	625	732	598	720	588	691	564
		9	65	28.7	40	50	726	597	694	573	687	567	668	552
		10	36	19.6	42	51	509	422	487	405	483	402	475	395
		11	15	9.9	44	52	262	219	251	211	250	209	247	207
		12	5	3.9	45	53	106	89	102	86	101	85	100	85
		13	1	.9	47	54	25	21	24	21	24	21	24	20
			520	152.2			3657	2970	3411	2789	3337	2729	3109	2539

ARITH. MEAN DBH= 7.1 , QUADRATIC MEAN DBH= 7.3 , WEIBULL PARAMETERS A= 1.4 , B= 6.33 , C= 3.19
PERCENT SURVIVAL= 52.0 , MEAN CROWN RATIO= 36.0 , LAMBDA= .561
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	ALL TREES GROUND TO TIP I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
30	55	2	1	.0	16	19	0	0						
		3	8	.4	20	29	7	5						
		4	22	1.9	23	37	37	28						
		5	42	5.7	26	42	120	93	111	87	98	76	58	43
		6	62	12.2	29	46	276	219	260	208	247	197	201	159
		7	75	20.0	31	49	484	391	461	373	448	363	415	337
		8	76	26.5	34	52	684	559	655	537	645	529	618	507
		9	67	29.6	36	54	798	658	764	633	756	627	735	609
		10	48	26.2	37	55	723	601	694	579	688	575	676	565
		11	29	19.1	39	57	548	459	527	443	524	441	517	435
		12	14	11.0	41	58	321	270	309	261	308	260	305	258
		13	6	5.5	43	59	164	139	158	135	158	134	157	133
		14	2	2.1	44	60	65	55	62	53	62	53	62	53
			452	160.4			4227	3477	4001	3309	3934	3255	3744	3099

ARITH. MEAN DBH= 7.8 , QUADRATIC MEAN DBH= 8.1 , WEIBULL PARAMETERS A= 1.6 , B= 6.88 , C= 3.05
PERCENT SURVIVAL= 45.2 , MEAN CROWN RATIO= 33.0 , LAMBDA= .627
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

YIELDS GIVEN T_P WITH IDEAL SURVIVAL —

T_P 1200

S_I 50

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft^2	Pct	Ft	Ft^3							
10	26	1	20	.1	55	10	1	0						
		2	144	3.1	56	18	42	22						
		3	320	15.7	56	23	228	143						
		4	283	24.7	56	25	361	246						
		5	88	12.0	56	27	180	129	162	117	147	106	113	80
		6	7	1.4	56	28	21	15	19	14	18	13	16	12
			862	57.0			833	555	181	131	165	119	129	92

ARITH. MEAN DBH= 3.3 , QUADRATIC MEAN DBH= 3.5 , WEIBULL PARAMETERS A= .3 , B= 3.36 , C= 3.61
PERCENT SURVIVAL= 71.8 , MEAN CROWN RATIO= 56.1 , LAMBDA= .019
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

15	38	1	1	.0	27	9	0	0						
		2	20	.4	34	21	7	4						
		3	78	3.8	38	28	56	37						
		4	164	14.3	41	32	238	170						
		5	215	29.3	44	35	531	399	487	369	440	332	293	212
		6	180	35.3	46	37	680	527	634	495	604	471	516	399
		7	88	23.5	48	39	478	379	449	358	438	349	408	325
		8	23	8.0	50	40	168	135	159	129	157	127	150	122
		9	3	1.3	52	41	27	21	25	20	25	20	24	19
			772	116.1			2185	1672	1754	1371	1664	1299	1391	1077

ARITH. MEAN DBH= 5.1 , QUADRATIC MEAN DBH= 5.2 , WEIBULL PARAMETERS A= .8 , B= 4.79 , C= 3.58
PERCENT SURVIVAL= 64.3 , MEAN CROWN RATIO= 44.3 , LAMBDA= .376
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

20	44	2	7	.2	24	21	2	1						
		3	34	1.7	29	29	28	20						
		4	81	7.1	32	35	130	98						
		5	132	18.0	35	38	351	271	326	253	293	227	174	127
		6	157	30.8	38	41	640	500	599	471	570	448	476	370
		7	135	36.1	41	43	790	630	746	[illegible]	726	582	675	540
		8	84	29.3	43	45	674	546	640	521	630	513	605	492
		9	35	15.5	45	46	365	[illegible]	348	286	344	293	335	276
		10	10	5.5	46	47	132	103	125	104	125	104	123	102
		11	2	1.3	48	48	33	27	31	26	31	26	31	26
			677	145.4			3145	2501	2816	2259	2719	2183	2419	1933

ARITH. MEAN DBH= 6.0 , QUADRATIC MEAN DBH= 6.3 , WEIBULL PARAMETERS A= 1.1 , B= 5.53 , C= 3.35
PERCENT SURVIVAL= 56.4 , MEAN CROWN RATIO= 38.3 , LAMBDA= [illegible]
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

YIELDS GIVEN T_P WITH IDEAL SURVIVAL —

T_P 1200

S_I 50

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
25	50	2	3	.1	18	20	1	1						
		3	18	.9	23	29	15	10						
		4	46	4.0	26	36	75	57						
		5	80	10.9	29	40	220	171	205	160	184	143	108	80
		6	108	21.2	32	44	464	368	437	348	419	334	339	268
		7	115	30.7	35	46	707	568	672	542	653	527	606	490
		8	99	34.6	37	48	837	680	797	650	784	640	752	614
		9	66	29.2	39	50	738	606	704	582	697	576	678	560
		10	34	18.5	41	51	480	398	460	383	456	380	449	373
		11	13	8.6	43	52	227	190	218	183	216	181	214	179
		12	4	3.1	44	53	85	71	81	69	81	68	80	68
		13	1	.9	46	54	25	21	24	21	24	21	24	20
			587	162.7			3874	3141	3598	2938	3514	2870	3250	2652

ARITH. MEAN DBH= 6.9 , QUADRATIC MEAN DBH= 7.1 , WEIBULL PARAMETERS A= 1.3 , B= 6.15 , C= 3.16
PERCENT SURVIVAL= 48.9 , MEAN CROWN RATIO= 34.2 , LAMBDA= .602
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

30	55	2	1	.0	14	19	0	0						
		3	10	.5	18	29	8	6						
		4	28	2.4	22	37	47	35						
		5	51	7.0	25	42	145	113	135	106	119	93	71	52
		6	73	14.3	28	46	324	258	306	244	290	232	237	187
		7	88	23.5	30	49	568	459	541	438	526	426	488	395
		8	86	30.0	32	52	774	633	741	607	730	599	700	574
		9	71	31.4	35	54	851	703	817	677	808	670	790	655
		10	49	26.7	36	55	738	614	708	591	702	586	690	577
		11	28	18.5	38	57	529	443	509	428	506	426	499	420
		12	13	10.2	40	58	298	251	287	243	286	242	283	239
		13	5	4.6	42	59	137	116	132	112	132	112	131	111
		14	1	1.1	43	60	32	27	31	27	31	27	31	26
			504	170.2			4451	3658	4207	3473	4130	3413	3920	3236

ARITH. MEAN DBH= 7.6 , QUADRATIC MEAN DBH= 7.9 , WEIBULL PARAMETERS A= 1.6 , B= 6.72 , C= 3.02
PERCENT SURVIVAL= 42.0 , MEAN CROWN RATIO= 31.4 , LAMBDA= .664
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

YIELDS GIVEN T_P WITH IDEAL SURVIVAL –

T_P 1500

S_I 50

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
10	26	1	41	.2	50	9	2	0						
		2	250	5.5	52	18	73	39						
		3	443	21.7	53	22	305	191						
		4	267	23.3	54	25	341	232						
		5	43	5.9	55	27	88	63	79	57	72	52	55	39
		6	1	.2	55	28	3	2	3	2	3	2	2	2
			1045	56.8			812	527	82	59	75	54	57	41

ARITH. MEAN DBH= 3.0 , QUADRATIC MEAN DBH= 3.1 , WEIBULL PARAMETERS A= .3 , B= 3.07 , C= 3.56
PERCENT SURVIVAL= 69.7 , MEAN CROWN RATIO= 53.3 , LAMBDA= .084
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

15	38	1	2	.0	24	9	0	0						
		2	33	.7	31	21	11	7						
		3	120	5.9	36	28	87	57						
		4	230	20.1	39	32	333	238						
		5	270	36.8	42	35	667	501	612	463	553	417	367	267
		6	186	36.5	45	37	703	545	655	511	625	487	533	412
		7	69	18.4	47	39	375	297	352	281	343	273	320	255
		8	12	4.2	49	40	88	71	83	67	82	66	79	63
		9	1	.4	51	41	9	7	8	7	8	7	8	6
			923	123.1			2273	1723	1710	1329	1611	1250	1307	1003

ARITH. MEAN DBH= 4.8 , QUADRATIC MEAN DBH= 4.9 , WEIBULL PARAMETERS A= .7 , B= 4.53 , C= 3.54
PERCENT SURVIVAL= 61.5 , MEAN CROWN RATIO= 41.7 , LAMBDA= .436
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

20	44	2	11	.2	22	21	4	2						
		3	50	2.5	26	29	41	29						
		4	113	9.9	30	34	178	133						
		5	172	23.5	34	38	457	353	424	330	382	296	226	166
		6	189	37.1	37	41	771	602	721	567	686	539	573	446
		7	147	39.3	39	43	861	686	812	651	790	634	735	588
		8	79	27.6	41	45	634	513	602	490	593	482	569	463
		9	28	12.4	44	46	292	239	278	229	275	226	268	221
		10	6	3.3	46	47	79	65	76	63	75	62	74	61
		11	1	.7	47	48	16	14	16	13	16	13	15	13
			796	156.3			3333	2636	2929	2343	2817	2252	2460	1958

ARITH. MEAN DBH= 5.8 , QUADRATIC MEAN DBH= 6.0 , WEIBULL PARAMETERS A= 1.0 , B= 5.29 , C= 3.31
PERCENT SURVIVAL= 53.1 , MEAN CROWN RATIO= 35.9 , LAMBDA= .569
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

YIELDS GIVEN T_P WITH IDEAL SURVIVAL —

T_P 1500

S_I 50

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --: 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
25	50	2	5	.1	16	20	2	1						
		3	25	1.2	21	30	21	15						
		4	62	5.4	24	36	101	76						
		5	104	14.2	28	41	292	227	271	212	244	190	143	105
		6	134	26.3	30	44	576	457	543	432	519	414	421	332
		7	136	36.3	33	47	850	684	808	653	786	635	729	590
		8	107	37.4	35	49	918	749	877	717	864	707	829	678
		9	66	29.2	38	50	738	606	704	582	697	576	678	560
		10	30	16.4	40	52	431	357	413	344	409	341	403	335
		11	10	6.6	42	53	178	148	170	143	169	142	167	140
		12	2	1.6	44	54	43	36	41	35	41	35	41	34
			681	174.6			4150	3356	3827	3118	3729	3040	3411	2774

ARITH. MEAN DBH= 6.6 , QUADRATIC MEAN DBH= 6.9 , WEIBULL PARAMETERS A= 1.3 , B= 5.93 , C= 3.13
PERCENT SURVIVAL= 45.4 , MEAN CROWN RATIO= 32.1 , LAMBDA= .652
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

30	55	2	2	.0	13	19	1	0						
		3	14	.7	17	29	11	8						
		4	36	3.1	20	37	60	45						
		5	64	8.7	23	42	182	142	170	133	149	116	89	65
		6	89	17.5	26	46	396	315	373	298	354	283	289	228
		7	104	27.8	29	49	671	542	639	518	621	504	576	467
		8	97	33.9	31	52	873	714	836	685	823	675	789	648
		9	77	34.0	33	54	922	762	886	734	877	726	856	710
		10	50	27.3	35	55	766	639	737	616	732	612	720	602
		11	27	17.8	37	57	510	428	491	413	488	410	481	405
		12	11	8.6	39	58	252	213	243	205	242	204	240	203
		13	4	3.7	41	59	110	93	106	90	105	89	104	89
		14	1	1.1	42	60	32	27	31	27	31	27	31	26
			576	184.2			4786	3928	4512	3719	4422	3646	4175	3443

ARITH. MEAN DBH= 7.4 , QUADRATIC MEAN DBH= 7.7 , WEIBULL PARAMETERS A= 1.5 , B= 6.52 , C= 2.99
PERCENT SURVIVAL= 38.4 , MEAN CROWN RATIO= 29.5 , LAMBDA= .709
CORRESPONDING SITE INDEX FOR BASE AGE 50= 73

YIELDS GIVEN T_P WITH IDEAL SURVIVAL —

T_P 400

S_I 60

							CUBIC FOOT VOLUME							
GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
10	31	2	4	.1	67	19	1	1						
		3	20	1.0	67	25	15	10						
		4	52	4.5	67	28	72	50						
		5	89	12.1	67	30	197	142	178	130	161	116	122	86
		6	96	18.6	67	31	309	229	282	211	268	200	235	175
		7	59	15.8	67	32	263	199	242	186	235	180	219	167
		8	18	6.3	67	33	107	83	99	77	97	76	93	73
		9	2	.9	67	34	15	12	14	11	14	11	14	11
			340	59.5			979	726	815	615	775	583	683	512

ARITH. MEAN DBH= 5.5 , QUADRATIC MEAN DBH= 5.7 , WEIBULL PARAMETERS A= .6 , B= 5.40 , C= 4.25
PERCENT SURVIVAL= 85.0 , MEAN CROWN RATIO= 66.7 , LAMBDA= .000
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

15	45	2	1	.0	43	23	0	0						
		3	4	.2	46	31	3	2						
		4	15	1.3	49	36	23	17						
		5	34	4.6	51	40	94	63	86	64	77	56	56	40
		6	58	11.4	52	42	236	178	219	167	208	158	177	134
		7	76	20.3	54	44	434	334	406	315	393	305	362	280
		8	70	24.4	55	46	541	424	509	402	499	394	475	374
		9	45	19.9	56	47	449	357	425	340	418	335	405	324
		10	18	9.8	57	48	227	183	215	175	213	173	209	169
		11	4	2.6	58	49	63	51	60	49	59	48	58	48
			325	94.6			2070	1615	1920	1512	1867	1469	1742	1369

ARITH. MEAN DBH= 7.1 , QUADRATIC MEAN DBH= 7.3 , WEIBULL PARAMETERS A= 1.0 , B= 6.73 , C= 4.20
PERCENT SURVIVAL= 81.3 , MEAN CROWN RATIO= 54.0 , LAMBDA= .266
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

20	53	3	2	.1	34	32	2	1						
		4	8	.7	38	39	13	10						
		5	20	2.7	41	44	58	45	54	41	47	36	29	21
		6	36	7.1	43	47	163	128	153	121	145	115	121	94
		7	52	13.9	45	49	337	271	320	258	311	251	288	233
		8	61	21.3	47	52	551	449	525	431	517	424	495	406
		9	56	24.7	49	53	657	541	629	520	622	515	605	501
		10	39	21.3	50	55	587	488	564	471	559	467	550	459
		11	20	13.2	52	56	351	287	335	276	333	273	327	269
		12	7	5.5	53	57	150	124	144	119	143	119	141	117
		13	2	1.8	54	57	51	42	49	41	49	41	48	40
			303	112.3			2920	2386	2773	2278	2726	2241	2604	2140

ARITH. MEAN DBH= 8.0 , QUADRATIC MEAN DBH= 8.2 , WEIBULL PARAMETERS A= 1.3 , B= 7.38 , C= 3.96
PERCENT SURVIVAL= 75.7 , MEAN CROWN RATIO= 47.1 , LAMBDA= .424
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

YIELDS GIVEN T_P WITH IDEAL SURVIVAL –

T_P 400

S_I 60

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
25	60	3	1	.0	27	33	1	1						
		4	5	.4	30	41	9	7						
		5	13	1.8	34	46	40	31	37	29	32	25	18	13
		6	24	4.7	36	51	116	92	109	87	103	82	85	67
		7	36	9.6	39	54	253	204	240	195	233	189	216	175
		8	47	16.4	41	56	451	369	431	355	424	349	406	334
		9	50	22.1	43	58	633	523	607	505	601	499	584	485
		10	44	24.0	45	60	714	596	687	575	681	571	669	561
		11	31	20.5	46	62	630	529	607	512	604	509	596	503
		12	17	13.4	48	63	419	354	404	343	402	341	399	338
		13	7	6.5	49	64	206	175	199	169	198	169	197	168
		14	2	2.1	51	65	67	57	65	55	65	55	64	54
			277	121.5			3539	2938	3386	2825	3343	2789	3234	2698

ARITH. MEAN DBH= 8.7 , QUADRATIC MEAN DBH= 9.0 , WEIBULL PARAMETERS A= 1.6 , B= 7.92 , C= 3.76
PERCENT SURVIVAL= 69.2 , MEAN CROWN RATIO= 42.3 , LAMBDA= .530
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
30	66	3	1	.0	22	33	1	1						
		4	3	.3	25	42	5	4						
		5	8	1.1	29	48	25	20	23	19	20	16	12	8
		6	16	3.1	31	53	79	64	75	60	71	57	57	46
		7	26	6.9	34	57	189	154	181	148	176	144	162	133
		8	34	11.9	36	60	345	284	331	273	325	269	311	257
		9	40	17.7	38	62	536	444	515	429	509	425	495	412
		10	40	21.8	40	64	686	574	661	555	655	551	644	541
		11	34	22.4	42	66	729	615	705	596	700	592	691	584
		12	24	18.8	44	67	624	529	603	513	601	510	595	506
		13	14	12.9	45	69	440	375	426	364	424	363	421	360
		14	6	6.4	47	70	222	190	215	184	215	184	213	183
		15	2	2.5	48	71	86	74	84	72	83	72	83	71
		16	1	1.4	49	72	50	43	48	42	48	42	48	41
			249	127.3			4017	3371	3867	3255	3827	3225	3732	3142

ARITH. MEAN DBH= 9.4 , QUADRATIC MEAN DBH= 9.7 , WEIBULL PARAMETERS A= 1.8 , B= 8.42 , C= 3.61
PERCENT SURVIVAL= 62.2 , MEAN CROWN RATIO= 38.9 , LAMBDA= .607
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

YIELDS GIVEN T_P WITH IDEAL SURVIVAL –

T_P 600

S_I 60

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
10	31	1	1	.0	61	11	0	0						
		2	11	.2	61	21	4	2						
		3	49	2.4	62	26	38	24						
		4	113	9.9	62	29	161	111						
		5	152	20.7	62	31	345	249	313	228	282	204	212	151
		6	113	22.2	62	32	373	277	341	256	323	242	283	210
		7	39	10.4	62	33	178	135	164	126	159	122	148	113
		8	5	1.7	62	34	30	24	28	22	28	22	27	21
			483	67.6			1129	822	846	632	792	590	670	495

ARITH. MEAN DBH= 4.9 , QUADRATIC MEAN DBH= 5.1 , WEIBULL PARAMETERS A= .5 , B= 4.87 , C= 4.16
PERCENT SURVIVAL= 80.5 , MEAN CROWN RATIO= 61.6 , LAMBDA= .005
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	I.B.	2 IN. O.B.	I.B.	3 IN. O.B.	I.B.	4 IN. O.B.	I.B.
15	45	2	2	.0	35	24	1	0						
		3	10	.5	40	32	8	5						
		4	32	2.8	43	37	51	37						
		5	66	9.0	46	40	179	136	165	126	145	110	91	66
		6	101	19.8	48	43	427	334	400	315	380	300	317	247
		7	109	29.1	50	45	661	529	625	503	608	489	565	453
		8	81	28.3	52	46	626	490	589	465	577	456	549	433
		9	37	16.3	53	47	370	294	349	280	344	276	333	267
		10	10	5.5	55	48	126	102	120	97	118	96	116	94
		11	1	.7	56	49	16	13	15	12	15	12	15	12
			449	112.0			2465	1940	2263	1798	2187	1739	1986	1572

ARITH. MEAN DBH= 6.6 , QUADRATIC MEAN DBH= 6.8 , WEIBULL PARAMETERS A= .9 , B= 6.25 , C= 4.13
PERCENT SURVIVAL= 74.8 , MEAN CROWN RATIO= 49.3 , LAMBDA= .376
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	I.B.	2 IN. O.B.	I.B.	3 IN. O.B.	I.B.	4 IN. O.B.	I.B.
20	53	2	1	.0	24	23	0	0						
		3	5	.2	29	33	4	3						
		4	16	1.4	33	40	28	21						
		5	36	4.9	36	44	105	80	97	74	84	65	52	38
		6	61	12.0	39	47	276	217	259	206	246	195	204	160
		7	81	21.6	42	50	534	430	507	[illegible]	492	398	457	369
		8	82	28.6	44	52	[illegible]	604	706	579	694	569	666	545
		9	67	29.6	46	53	766	648	752	623	744	616	724	599
		10	38	20.7	48	55	572	476	549	459	545	455	535	447
		11	15	9.9	49	56	279	234	268	225	267	224	263	221
		12	4	3.1	51	57	86	71	82	68	82	68	81	67
		13	1	.9	53	57	26	21	24	20	24	20	24	20
			407	133.1			3436	2805	3244	2664	3178	2610	3006	2466

ARITH. MEAN DBH= 7.5 , QUADRATIC MEAN DBH= 7.7 , WEIBULL PARAMETERS A= 1.2 , B= 6.[illegible]4 , C= 3.89
PERCENT SURVIVAL= 67.8 , MEAN CROWN RATIO= 42.8 , LAMBDA= .524
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

YIELDS GIVEN T_P WITH IDEAL SURVIVAL –

T_P 600

S_I 60

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
25	60	3	3	.1	23	34	3	2						
		4	9	.8	27	42	16	12						
		5	22	3.0	30	47	68	54	63	50	55	44	31	23
		6	39	7.7	33	51	187	150	177	143	168	135	136	108
		7	56	15.0	35	54	390	317	373	303	362	295	335	273
		8	66	23.0	38	57	643	527	615	506	604	498	579	476
		9	65	28.7	40	59	834	691	801	666	793	659	770	640
		10	51	27.8	42	60	827	690	796	667	789	661	776	650
		11	31	20.5	44	62	630	529	607	512	604	509	596	503
		12	14	11.0	46	63	345	292	333	282	331	281	328	279
		13	5	4.6	47	64	147	125	142	121	142	121	141	120
		14	1	1.1	49	65	35	30	33	29	33	29	33	28
			362	143.3			4125	3419	3940	3279	3881	3232	3725	3100

ARITH. MEAN DBH= 8.3 , QUADRATIC MEAN DBH= 8.5 , WEIBULL PARAMETERS A= 1.5 , B= 7.52 , C= 3.70
PERCENT SURVIVAL= 60.3 , MEAN CROWN RATIO= 38.4 , LAMBDA= .621
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
30	66	3	1	.0	19	34	1	1						
		4	6	.5	22	43	11	8						
		5	14	1.9	25	49	45	35	42	33	36	29	20	14
		6	25	4.9	28	54	126	101	119	96	113	91	91	73
		7	38	10.2	31	58	280	229	268	219	260	213	238	195
		8	49	17.1	33	61	503	414	483	399	476	393	455	377
		9	55	24.3	35	63	750	624	723	603	715	597	698	583
		10	49	26.7	38	65	851	713	821	690	814	684	800	672
		11	38	25.1	39	67	826	696	796	675	793	671	783	662
		12	24	18.8	41	68	632	536	611	520	609	518	603	513
		13	12	11.1	43	70	382	325	370	316	369	315	366	313
		14	5	5.3	45	71	187	160	182	156	181	155	180	155
		15	1	1.2	46	72	44	37	42	36	42	36	42	36
			317	147.2			4638	3879	4459	3743	4408	3702	4276	3593

ARITH. MEAN DBH= 9.0 , QUADRATIC MEAN DBH= 9.3 , WEIBULL PARAMETERS A= 1.7 , B= 8.06 , C= 3.55
PERCENT SURVIVAL= 52.8 , MEAN CROWN RATIO= 35.4 , LAMBDA= .689
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

YIELDS GIVEN T_P WITH IDEAL SURVIVAL —

T_P 800

S_I 60

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
10	31	1	2	.0	53	11	0	0						
		2	24	.5	55	21	8	4						
		3	93	4.6	57	26	73	46						
		4	185	16.1	58	29	263	181						
		5	197	26.9	58	31	447	322	405	295	365	265	275	195
		6	99	19.4	59	32	326	242	299	224	283	212	248	184
		7	19	5.1	59	33	87	66	80	61	78	60	72	55
		8	1	.3	60	34	6	5	6	4	6	4	5	4
			620	73.0			1210	866	790	584	732	541	600	438

ARITH. MEAN DBH= 4.5 , QUADRATIC MEAN DBH= 4.6 , WEIBULL PARAMETERS A= .4 , B= 4.50 , C= 4.11
PERCENT SURVIVAL= 77.5 , MEAN CROWN RATIO= 58.0 , LAMBDA= .089
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
15	45	2	3	.1	31	25	1	1						
		3	18	.9	36	33	14	9						
		4	53	4.6	40	38	86	62						
		5	104	14.2	43	41	287	219	265	203	232	177	145	105
		6	143	28.1	45	44	615	483	577	455	548	433	457	356
		7	133	35.5	48	46	821	657	777	625	755	608	702	564
		8	79	27.6	50	47	657	533	624	509	614	501	590	481
		9	27	11.9	52	48	274	218	259	208	256	205	248	198
		10	5	2.7	53	49	64	52	61	49	60	49	59	48
			565	125.6			2819	2234	2563	2049	2465	1973	2201	1752

ARITH. MEAN DBH= 6.2 , QUADRATIC MEAN DBH= 6.4 , WEIBULL PARAMETERS A= .8 , B= 5.91 , C= 4.08
PERCENT SURVIVAL= 70.6 , MEAN CROWN RATIO= 46.0 , LAMBDA= .453
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
20	53	2	1	.0	21	24	0	0						
		3	8	.4	26	34	7	5						
		4	26	2.3	30	41	46	35						
		5	55	7.5	34	45	165	129	154	121	134	105	76	56
		6	88	17.3	37	48	405	319	380	302	361	287	299	235
		7	107	28.6	39	51	717	577	681	551	661	535	613	495
		8	102	35.6	42	53	935	764	893	732	878	720	841	690
		9	70	30.9	44	54	834	688	799	662	790	655	768	636
		10	33	18.0	46	55	497	413	477	398	473	395	465	388
		11	10	6.6	48	57	189	158	182	153	181	152	178	150
		12	2	1.6	50	57	45	38	43	37	43	37	43	36
			502	148.8			3840	3126	3609	2956	3521	2886	3283	2686

ARITH. MEAN DBH= 7.2 , QUADRATIC MEAN DBH= 7.4 , WEIBULL PARAMETERS A= 1.2 , B= 6.63 , C= 3.84
PERCENT SURVIVAL= 62.7 , MEAN CROWN RATIO= 39.8 , LAMBDA= .595
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

YIELDS GIVEN T_P WITH IDEAL SURVIVAL —

T_P 800

S_I 60

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
25	60	3	4	.2	20	34	4	3						
		4	14	1.2	24	42	25	19						
		5	32	4.4	27	48	100	79	94	74	82	65	46	34
		6	54	10.6	30	51	260	208	245	197	233	187	189	150
		7	75	20.0	33	55	530	431	507	413	492	401	455	371
		8	85	29.7	36	57	827	678	792	652	778	641	745	613
		9	76	33.6	38	59	976	808	937	779	927	771	900	749
		10	54	29.5	40	60	876	731	843	706	836	700	821	688
		11	29	19.1	42	62	589	495	568	479	565	477	557	470
		12	12	9.4	44	63	296	250	285	242	284	241	281	239
		13	3	2.8	46	64	88	75	85	73	85	72	84	72
		14	1	1.1	48	65	35	30	33	29	33	29	33	28
			439	161.5			4606	3807	4389	3644	4315	3584	4111	3414

ARITH. MEAN DBH= 8.0 , QUADRATIC MEAN DBH= 8.2 , WEIBULL PARAMETERS A= 1.4 , B= 7.24 , C= 3.65
PERCENT SURVIVAL= 54.9 , MEAN CROWN RATIO= 35.6 , LAMBDA= .685
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
30	66	3	2	.1	16	35	2	1						
		4	8	.7	20	43	15	11						
		5	19	2.6	23	50	61	49	57	46	50	40	27	20
		6	34	6.7	26	54	171	137	162	131	153	124	124	99
		7	50	13.4	29	58	369	301	353	289	343	280	313	256
		8	62	21.6	31	61	636	524	611	505	602	498	576	477
		9	64	28.3	34	63	873	726	842	702	833	694	813	678
		10	56	30.5	36	65	973	815	938	789	930	782	914	768
		11	41	27.1	38	67	891	751	861	729	856	724	844	714
		12	24	18.8	40	68	632	536	611	520	609	518	603	513
		13	11	10.1	42	70	350	298	339	290	338	289	335	287
		14	4	4.3	43	71	150	128	145	125	145	124	144	124
		15	1	1.2	45	72	44	37	42	36	42	36	42	36
			376	165.4			5167	4314	4961	4162	4901	4109	4735	3972

ARITH. MEAN DBH= 8.7 , QUADRATIC MEAN DBH= 9.0 , WEIBULL PARAMETERS A= 1.7 , B= 7.81 , C= 3.51
PERCENT SURVIVAL= 47.0 , MEAN CROWN RATIO= 32.9 , LAMBDA= .747
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

YIELDS GIVEN T_P WITH IDEAL SURVIVAL —

T_P 1000

S_I 60

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft^2	Pct	Ft	Ft^3							
10	31	1	4	.0	47	11	0	0						
		2	43	.9	51	22	15	8						
		3	151	7.4	53	27	121	78						
		4	259	22.6	55	30	378	261						
		5	216	29.5	56	32	502	362	456	332	410	298	307	219
		6	72	14.1	57	33	243	181	223	168	211	158	184	137
		7	7	1.9	58	34	33	25	30	23	29	22	27	21
			----	------			-----	-----	-----	-----	-----	-----	-----	-----
			752	76.4			1292	915	709	523	650	478	518	377

ARITH. MEAN DBH= 4.2 , QUADRATIC MEAN DBH= 4.3 , WEIBULL PARAMETERS A= .4 , B= 4.22 , C= 4.06
PERCENT SURVIVAL= 75.2 , MEAN CROWN RATIO= 55.2 , LAMBDA= .155
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

15	45	2	5	.1	28	25	2	1						
		3	29	1.4	33	33	26	19						
		4	80	7.0	37	38	129	94						
		5	145	19.8	41	41	401	305	369	283	324	247	202	146
		6	181	35.5	44	44	778	611	730	576	694	548	578	451
		7	146	39.0	46	46	901	721	853	686	829	667	770	619
		8	70	24.4	49	47	582	472	553	451	544	444	522	426
		9	18	8.0	51	48	183	145	173	139	170	137	165	132
		10	2	1.1	53	49	26	21	24	20	24	20	24	19
			----	------			-----	-----	-----	-----	-----	-----	-----	-----
			676	136.3			3028	2389	2702	2155	2585	2063	2261	1793

ARITH. MEAN DBH= 5.9 , QUADRATIC MEAN DBH= 6.1 , WEIBULL PARAMETERS A= .8 , B= 5.64 , C= 4.04
PERCENT SURVIVAL= 67.6 , MEAN CROWN RATIO= 43.4 , LAMBDA= .513
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

20	53	2	2	.0	19	25	1	0						
		3	12	.6	24	35	11	8						
		4	37	3.2	28	41	66	50						
		5	75	10.2	32	45	225	176	209	165	183	144	104	77
		6	115	22.6	35	48	528	421	498	399	473	379	384	305
		7	131	35.0	38	51	878	707	833	675	809	655	750	606
		8	114	39.8	40	53	1045	853	998	819	991	805	940	771
		9	69	30.5	43	54	822	678	787	652	779	646	757	627
		10	28	15.3	45	55	422	351	405	338	401	335	395	329
		11	7	4.6	47	57	132	111	127	107	126	106	125	105
		12	1	.8	49	57	23	19	22	18	22	18	21	18
			----	------			-----	-----	-----	-----	-----	-----	- ---	-----
			591	162.6			4153	3374	3879	3173	3774	3088	3476	2838

ARITH. MEAN DBH= 6.9 , QUADRATIC MEAN DBH= 7.1 , WEIBULL PARAMETERS A= 1.1 , B= 6.39 , C= 3.80
PERCENT SURVIVAL= 59.1 , MEAN CROWN RATIO= 37.4 , LAMBDA= .650
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

YIELDS GIVEN T_P WITH IDEAL SURVIVAL –

T_P 1000

S_I 60

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
25	60	2	1	.0	14	24	0	0						
		3	6	.3	18	35	5	4						
		4	20	1.7	22	43	37	28						
		5	42	5.7	26	48	132	104	123	98	107	85	61	45
		6	70	13.7	29	52	341	274	323	260	306	247	248	198
		7	93	24.9	32	55	658	534	628	512	610	498	565	461
		8	100	34.9	34	58	984	809	945	779	930	767	891	735
		9	84	37.1	37	60	1094	906	1051	874	1039	865	1010	840
		10	55	30.0	39	61	905	756	871	730	864	724	849	712
		11	27	17.8	41	63	556	468	536	453	533	450	526	444
		12	9	7.1	43	64	225	190	217	184	216	183	214	182
		13	2	1.8	45	65	60	51	58	49	57	49	57	49
			509	175.1			4997	4124	4752	3939	4662	3868	4421	3666

ARITH. MEAN DBH= 7.7 , QUADRATIC MEAN DBH= 8.0 , WEIBULL PARAMETERS A= 1.4 , B= 7.02 , C= 3.62
PERCENT SURVIVAL= 50.9 , MEAN CROWN RATIO= 33.5 , LAMBDA= .735
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

30	66	3	3	.1	15	35	3	2						
		4	11	1.0	18	44	21	16						
		5	25	3.4	22	50	81	64	76	60	66	52	35	26
		6	43	8.4	25	55	219	176	208	168	196	159	159	127
		7	61	16.3	27	58	450	367	431	352	418	342	382	312
		8	73	25.5	30	61	749	617	720	595	709	586	678	561
		9	74	32.7	32	63	1009	839	973	811	963	803	940	784
		10	61	33.3	34	65	1078	905	1043	877	1035	871	1017	856
		11	42	27.7	37	67	913	770	882	746	877	742	865	732
		12	23	18.1	39	68	606	513	586	498	583	496	578	491
		13	9	8.3	41	70	286	244	277	237	276	236	274	235
		14	3	3.2	42	71	112	96	109	93	109	93	108	93
		15	1	1.2	44	72	44	37	42	36	42	36	42	36
			429	179.2			5571	4646	5347	4473	5274	4416	5078	4253

ARITH. MEAN DBH= 8.5 , QUADRATIC MEAN DBH= 8.7 , WEIBULL PARAMETERS A= 1.6 , B= 7.61 , C= 3.48
PERCENT SURVIVAL= 42.9 , MEAN CROWN RATIO= 30.9 , LAMBDA= .791
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

YIELDS GIVEN T_P WITH IDEAL SURVIVAL —

T_P 1200

S_I 60

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	ALL TREES GROUND TO TIP I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
10	31	1	7	.0	43	11	0	0						
		2	70	1.5	48	21	19	10						
		3	221	10.8	51	26	173	110						
		4	327	28.5	53	29	466	320						
		5	208	28.4	55	31	472	340	428	312	385	279	290	206
		6	45	8.8	56	33	152	113	139	105	132	99	115	86
		7	2	.5	57	34	9	7	9	7	8	6	8	6
			880	78.7			1291	900	576	424	525	384	413	298

ARITH. MEAN DBH= 3.9 , QUADRATIC MEAN DBH= 4.0 , WEIBULL PARAMETERS A= .3 , B= 3.98 , C= 4.03
PERCENT SURVIVAL= 73.3 , MEAN CROWN RATIO= 52.9 , LAMBDA= .208
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
15	45	2	8	.2	26	25	3	2						
		3	42	2.1	31	33	37	27						
		4	110	9.6	35	38	186	141						
		5	188	25.6	39	41	519	395	479	367	420	320	262	190
		6	214	42.0	42	44	920	722	863	681	820	648	683	533
		7	149	39.8	45	46	920	736	870	700	846	681	786	631
		8	58	20.2	48	47	482	391	458	374	451	368	433	353
		9	11	4.9	50	48	119	98	113	93	112	92	109	90
		10	1	.5	52	49	13	10	12	10	12	10	12	10
			781	145.0			3199	2522	2795	2225	2661	2119	2285	1807

ARITH. MEAN DBH= 5.7 , QUADRATIC MEAN DBH= 5.8 , WEIBULL PARAMETERS A= .7 , B= 5.42 , C= 4.00
PERCENT SURVIVAL= 65.1 , MEAN CROWN RATIO= 41.3 , LAMBDA= .562
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
20	53	2	3	.1	17	25	1	1						
		3	17	.8	22	35	16	11						
		4	49	4.3	26	41	87	67						
		5	97	13.2	30	45	291	228	271	214	237	186	135	99
		6	142	27.9	33	48	652	520	615	493	584	468	475	377
		7	153	40.9	36	51	1025	826	973	788	945	765	876	708
		8	121	42.2	39	53	1109	906	1059	869	1041	855	998	818
		9	65	28.7	42	54	774	639	742	614	734	608	713	591
		10	22	12.0	44	55	331	276	318	265	315	263	310	259
		11	5	3.3	46	57	94	79	91	76	90	76	89	75
		12	1	.8	48	57	23	19	22	18	22	18	21	18
			675	174.2			4403	3572	4091	3337	3968	3239	3617	2945

ARITH. MEAN DBH= 6.7 , QUADRATIC MEAN DBH= 6.9 , WEIBULL PARAMETERS A= 1.1 , B= 6.19 , C= 3.77
PERCENT SURVIVAL= 56.3 , MEAN CROWN RATIO= 35.5 , LAMBDA= .695
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

YIELDS GIVEN T_P WITH IDEAL SURVIVAL —

T_P 1200

S_I 60

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft^2	Pct	Ft	Ft^3							
25	60	2	1	.0	13	24	0	0						
		3	8	.4	17	35	7	5						
		4	26	2.3	21	43	48	37						
		5	54	7.4	24	48	169	134	158	125	138	109	78	57
		6	86	16.9	27	52	419	336	397	320	376	303	305	243
		7	110	29.4	30	55	778	632	743	606	721	589	668	545
		8	112	39.1	33	58	1102	906	1058	872	1042	859	997	823
		9	90	39.8	36	60	1172	971	1126	937	1114	927	1082	900
		10	54	29.5	38	61	888	742	855	717	848	711	833	699
		11	24	15.8	40	63	494	416	477	403	474	400	468	395
		12	7	5.5	42	64	175	148	169	143	168	143	167	141
		13	2	1.8	44	65	60	51	58	49	57	49	57	49
			574	187.8			5312	4378	5041	4172	4938	4090	4655	3852

ARITH. MEAN DBH= 7.5 , QUADRATIC MEAN DBH= 7.7 , WEIBULL PARAMETERS A= 1.3 , B= 6.83 , C= 3.59
PERCENT SURVIVAL= 47.8 , MEAN CROWN RATIO= 31.7 , LAMBDA= .776
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
30	66	3	4	.2	14	35	4	3						
		4	14	1.2	17	44	26	20						
		5	31	4.2	20	51	102	81	95	76	83	66	44	33
		6	52	10.2	23	55	265	213	251	203	237	192	192	154
		7	72	19.2	26	59	539	439	516	422	500	410	457	374
		8	85	29.7	29	62	884	729	850	703	837	692	801	663
		9	82	36.2	31	64	1133	943	1094	912	1081	903	1056	882
		10	65	35.5	33	66	1164	978	1126	948	1118	941	1099	325
		11	42	27.7	36	68	925	780	894	757	889	752	877	742
		12	21	16.5	38	69	560	475	542	461	540	459	535	455
		13	8	7.4	40	70	255	217	247	211	246	210	244	208
		14	2	2.1	42	72	76	65	74	63	73	63	73	63
			478	190.2			5933	4943	5689	4756	5604	4688	5378	4499

ARITH. MEAN DBH= 8.3 , QUADRATIC MEAN DBH= 8.6 , WEIBULL PARAMETERS A= 1.6 , B= 7.45 , C= 3.46
PERCENT SURVIVAL= 39.8 , MEAN CROWN RATIO= 29.4 , LAMBDA= .828
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

YIELDS GIVEN T_P WITH IDEAL SURVIVAL —

T_P 1500

S_I 60

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TPEES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No.	Ft²	Pct	Ft	Ft³							
10	31	1	14	.1	39	11	1	0						
		2	126	2.7	45	21	34	18						
		3	345	16.9	48	27	245	159						
		4	399	34.8	51	30	583	402						
		5	166	22.6	53	32	386	279	350	256	315	229	236	168
		6	18	3.5	55	34	62	46	57	43	54	41	47	35
			1068	80.7			1311	904	407	299	369	270	283	203

ARITH. MEAN DBH= 3.6 , QUADRATIC MEAN DBH= 3.7 , WEIBULL PARAMETERS A= .2 , B= 3.69 , C= 3.98
PERCENT SURVIVAL= 71.2 , MEAN CROWN RATIO= 50.1 , LAMBDA= .273
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

15	45	1	1	.0	16	11	0	0						
		2	14	.3	23	25	5	3						
		3	66	3.2	29	33	58	42						
		4	163	14.2	34	39	281	214						
		5	253	34.5	37	42	711	542	656	504	574	439	357	259
		6	249	48.9	41	44	1071	840	1004	793	955	753	795	620
		7	142	37.9	44	46	877	702	829	668	806	649	749	602
		8	41	14.3	47	48	347	282	330	269	325	265	311	254
		9	5	2.2	49	49	55	45	52	43	52	43	51	42
			934	155.6			3405	2670	2871	2277	2712	2149	2263	1777

ARITH. MEAN DBH= 5.4 , QUADRATIC MEAN DBH= 5.5 , WEIBULL PARAMETERS A= .7 , B= 5.16 , C= 3.96
PERCENT SURVIVAL= 62.3 , MEAN CROWN RATIO= 38.7 , LAMBDA= .622
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

20	53	2	4	.1	15	25	1	1						
		3	25	1.2	20	35	23	17						
		4	71	6.2	25	41	127	97						
		5	133	18.1	28	46	405	318	377	298	329	259	187	138
		6	182	35.7	32	49	848	678	802	643	760	610	618	491
		7	180	48.1	35	52	1218	986	1161	944	1128	918	1045	850
		8	125	43.6	38	54	1164	951	1112	913	1093	898	1047	860
		9	57	25.2	41	55	690	569	661	548	654	542	636	527
		10	16	8.7	43	56	245	204	235	196	233	195	229	191
		11	2	1.3	45	57	38	32	36	31	36	30	36	30
			795	188.3			4759	3853	4384	3573	4233	3452	3798	3087

ARITH. MEAN DBH= 6.4 , QUADRATIC MEAN DBH= 6.6 , WEIBULL PARAMETERS A= 1.0 , B= 5.94 , C= 3.73
PERCENT SURVIVAL= 53.0 , MEAN CROWN RATIO= 33.1 , LAMBDA= .750
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

YIELDS GIVEN T_P WITH IDEAL SURVIVAL –

T_P 1500

S_I 60

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
25	60	2	2	.0	11	24	1	0						
		3	12	.6	16	35	11	8						
		4	35	3.1	19	43	64	49						
		5	71	9.7	23	48	223	176	208	165	181	143	102	75
		6	110	21.6	26	52	537	430	508	409	481	388	390	311
		7	133	35.5	29	55	941	764	898	732	872	712	807	659
		8	129	45.0	32	58	1270	1044	1219	1004	1200	990	1149	948
		9	95	42.0	34	60	1243	1032	1198	996	1184	986	1156	963
		10	52	28.4	37	61	855	714	823	690	817	685	802	673
		11	20	13.2	39	63	412	347	397	335	395	334	390	329
		12	5	3.9	41	64	125	106	121	102	120	102	119	101
		13	1	.9	43	65	30	25	29	25	29	24	29	24
			665	203.9			5712	4695	5401	4458	5279	4364	4944	4083

ARITH. MEAN DBH= 7.3 , QUADRATIC MEAN DBH= 7.5 , WEIBULL PARAMETERS A= 1.3 , B= 6.61 , C= 3.56
PERCENT SURVIVAL= 44.3 , MEAN CROWN RATIO= 29.6 , LAMBDA= .826
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES GROUND TO TIP O.B.	I.B.	2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
30	66	2	1	.0	9	23	0	0						
		3	6	.3	13	35	5	4						
		4	19	1.7	16	44	35	27						
		5	40	5.5	19	51	131	104	123	98	107	85	57	42
		6	65	12.8	22	55	331	267	314	254	297	240	240	192
		7	88	23.5	25	59	658	537	630	516	611	501	559	457
		8	98	34.2	27	62	1019	840	980	810	965	798	923	764
		9	91	40.2	30	64	1258	1047	1214	1012	1200	1002	1171	978
		10	69	37.6	32	66	1236	1038	1196	1006	1187	999	1166	982
		11	41	27.1	34	68	932	790	904	768	899	763	889	755
		12	19	14.9	36	69	507	430	491	417	488	415	484	412
		13	7	6.5	39	70	223	190	216	184	215	184	213	182
		14	2	2.1	40	72	76	65	74	63	73	63	73	63
			546	206.3			6411	5339	6142	5128	6042	5050	5775	4827

ARITH. MEAN DBH= 8.1 , QUADRATIC MEAN DBH= 8.3 , WEIBULL PARAMETERS A= 1.5 , B= 7.25 , C= 3.43
PERCENT SURVIVAL= 36.4 , MEAN CROWN RATIO= 27.4 , LAMBDA= .873
CORRESPONDING SITE INDEX FOR BASE AGE 50= 88

YIELDS GIVEN T_P WITH IDEAL SURVIVAL –

T_P 400

S_I 70

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
10	37	2	2	.0	62	23	1	0						
		3	11	.5	63	29	9	6						
		4	35	3.1	63	32	54	37						
		5	71	9.7	64	35	177	128	161	118	144	105	107	76
		6	99	19.4	64	37	365	273	337	255	320	241	275	206
		7	83	22.2	64	38	422	323	392	303	381	294	352	270
		8	37	12.9	65	39	251	195	234	184	229	180	219	172
		9	7	3.1	65	40	61	48	58	46	57	45	55	44
			345	70.9			1340	1010	1182	906	1131	865	1008	768

ARITH. MEAN DBH= 6.0 , QUADRATIC MEAN DBH= 6.1 , WEIBULL PARAMETERS A= .6 , B= 5.93 , C= 4.60
PERCENT SURVIVAL= 86.2 , MEAN CROWN RATIO= 64.1 , LAMBDA= .045
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
15	53	3	2	.1	39	36	2	1						
		4	9	.8	42	42	16	11						
		5	23	3.1	46	46	69	53	64	49	56	43	34	25
		6	44	8.6	48	49	206	162	193	154	184	146	152	119
		7	67	17.9	50	51	449	361	426	345	414	335	384	310
		8	75	26.2	52	53	651	513	616	489	603	479	573	454
		9	61	26.9	54	54	683	546	649	523	639	515	618	497
		10	32	17.5	56	55	453	366	431	351	427	347	418	340
		11	10	6.6	57	56	176	143	168	138	166	137	164	134
		12	2	1.6	58	57	43	35	41	34	41	34	40	33
			325	109.3			2748	2191	2588	2083	2530	2036	2383	1912

ARITH. MEAN DBH= 7.7 , QUADRATIC MEAN DBH= 7.8 , WEIBULL PARAMETERS A= 1.0 , B= 7.28 , C= 4.56
PERCENT SURVIVAL= 81.3 , MEAN CROWN RATIO= 51.6 , LAMBDA= .419
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
20	62	3	1	.0	28	37	1	1						
		4	4	.3	32	45	8	6						
		5	12	1.6	36	50	38	30	35	28	31	24	19	14
		6	25	4.9	39	54	126	100	119	95	113	90	93	73
		7	41	11.0	41	57	301	244	286	233	278	226	257	209
		8	56	19.5	44	59	561	461	537	443	528	436	506	417
		9	60	26.5	46	61	792	657	762	634	753	627	732	609
		10	50	27.3	48	63	846	707	815	684	808	678	794	666
		11	30	19.8	50	64	627	527	605	511	601	508	593	501
		12	13	10.2	52	65	313	259	301	250	299	249	295	246
		13	3	2.8	53	66	87	73	84	70	83	70	83	69
		14	1	1.[illegible]	55	67	35	29	33	28	33	28	33	28
			296	125.1			3735	3094	3577	2976	3527	2936	3405	2832

ARITH. MEAN DBH= 8.6 , QUADRATIC MEAN DBH= 8.8 , WEIBULL PARAMETERS A= 1.3 , B= 7.97 , C= 4.32
PERCENT SURVIVAL= 74.0 , MEAN CROWN RATIO= 45.0 , LAMBDA= .570
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

YIELDS GIVEN T_P WITH IDEAL SURVIVAL —

T_P 400

S_I 70

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
25	70	3	1	.0	22	38	1	1						
		4	3	.3	26	47	6	5						
		5	7	1.0	29	53	24	19	22	18	19	15	10	8
		6	15	2.9	32	58	80	64	76	61	71	58	58	46
		7	26	6.9	35	62	202	166	194	159	188	155	172	141
		8	38	13.3	38	65	413	341	397	329	390	323	373	309
		9	46	20.3	40	67	658	548	634	530	627	524	609	509
		10	47	25.6	42	69	860	722	831	700	824	694	809	681
		11	39	25.7	44	71	892	753	863	732	858	727	847	718
		12	25	19.6	46	72	693	588	671	572	668	569	662	564
		13	12	11.1	48	74	401	342	389	333	388	332	365	330
		14	4	4.3	49	75	157	135	153	131	152	131	152	130
		15	1	1.2	51	76	45	38	44	37	44	37	43	37
			264	132.3			4432	3722	4274	3602	4229	3565	4120	3473

ARITH. MEAN DBH= 9.3 , QUADRATIC MEAN DBH= 9.6 , WEIBULL PARAMETERS A= 1.6 , B= 8.54 , C= 4.13
PERCENT SURVIVAL= 66.0 , MEAN CROWN RATIO= 40.6 , LAMBDA= .667
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
30	77	4	1	.1	21	48	2	2						
		5	4	.5	25	56	14	11	13	11	11	9	6	4
		6	10	2.0	28	61	55	45	52	43	50	40	38	31
		7	17	4.5	30	66	139	114	134	110	130	107	118	97
		8	26	9.1	33	69	296	245	285	237	281	233	268	223
		9	33	14.6	35	72	504	422	488	409	483	405	471	395
		10	38	20.7	38	75	748	630	724	612	718	607	705	595
		11	36	23.8	40	77	885	749	858	729	853	725	842	715
		12	29	22.8	42	79	873	743	848	724	843	720	835	714
		13	19	17.5	44	80	681	583	662	568	660	566	655	562
		14	10	10.7	45	81	422	362	410	353	409	352	407	350
		15	4	4.9	47	82	196	169	191	165	191	165	190	164
		16	1	1.4	49	83	56	49	55	48	55	48	55	47
			228	132.6			4871	4124	4720	4009	4684	3977	4590	3897

ARITH. MEAN DBH= 10.1 , QUADRATIC MEAN DBH= 10.3 , WEIBULL PARAMETERS A= 1.8 , B= 9.10 , C= 3.99
PERCENT SURVIVAL= 57.0 , MEAN CROWN RATIO= 37.7 , LAMBDA= .732
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

YIELDS GIVEN T_P WITH IDEAL SURVIVAL —

T_P 600

S_I 70

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME — ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF — 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
10	37	2	5	.1	53	24	2	1						
		3	28	1.4	56	30	24	16						
		4	79	6.9	57	33	124	86						
		5	138	18.8	59	35	344	249	313	229	280	205	208	148
		6	145	28.5	60	37	534	400	493	373	468	354	403	302
		7	77	20.6	61	38	391	299	364	281	353	273	326	251
		8	17	5.9	61	39	115	90	108	84	105	83	101	79
		9	1	.4	62	40	9	7	8	7	8	6	8	6
			490	82.6			1543	1148	1286	974	1214	921	1046	786

ARITH. MEAN DBH= 5.4 . QUADRATIC MEAN DBH= 5.5 . WEIBULL PARAMETERS A= .5 . B= 5.40 . C= 4.52
PERCENT SURVIVAL= 81.7 . MEAN CROWN RATIO= 59.0 . LAMBDA= .164
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	I.B.	2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
15	53	2	1	.0	28	28	0	0						
		3	5	.2	33	38	5	4						
		4	19	1.7	37	43	33	24						
		5	46	6.3	41	47	140	108	130	101	113	87	69	50
		6	82	16.1	44	50	389	308	366	292	347	277	288	226
		7	108	28.9	47	52	735	593	698	566	678	550	628	508
		8	101	35.3	49	54	940	769	898	738	883	725	846	695
		9	61	26.9	51	55	694	555	660	531	650	523	628	506
		10	22	12.0	53	56	316	256	301	245	298	243	292	237
		11	4	2.6	55	57	71	58	68	56	68	56	66	55
			449	130.0			3323	2675	3121	2529	3037	2461	2817	2277

ARITH. MEAN DBH= 7.1 . QUADRATIC MEAN DBH= 7.3 . WEIBULL PARAMETERS A= .9 . B= 6.80 C= 4.49
PERCENT SURVIVAL= 74.8 . MEAN CROWN RATIO= 46.9 . LAMBDA= .529
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	I.B.	2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
20	62	3	2	.1	24	39	2	1						
		4	9	.8	28	46	17	13						
		5	23	3.1	32	52	77	61	72	57	62	49	33	24
		6	44	8.6	35	55	224	180	212	172	201	163	162	130
		7	68	18.2	38	58	506	410	482	393	468	381	432	352
		8	84	29.3	41	60	853	701	818	675	804	664	769	635
		9	79	34.9	43	62	1058	878	1017	848	1006	839	977	814
		10	54	29.5	45	64	926	775	892	750	885	743	869	730
		11	26	17.2	47	65	550	463	531	449	528	446	521	440
		12	8	6.3	49	66	205	174	198	169	197	168	196	166
		13	1	.9	51	67	29	25	28	24	28	24	28	23
			398	148.9			4447	3681	4250	3537	4179	3477	3987	3314

ARITH. MEAN DBH= 8.1 . QUADRATIC MEAN DBH= 8.3 . WEIBULL PARAMETERS A= 1.2 . B= 7.52 . C= 4.25
PERCENT SURVIVAL= 66.3 . MEAN CROWN RATIO= 40.7 . LAMBDA= .670
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

YIELDS GIVEN T_P WITH IDEAL SURVIVAL –

T_P 600

S_I 70

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	ALL TREES GROUND TO TIP I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
25	70	3	1	.0	18	39	1	1						
		4	5	.4	22	49	10	8						
		5	13	1.8	26	55	45	36	42	34	37	29	19	14
		6	26	5.1	29	60	142	115	135	109	127	104	99	79
		7	42	11.2	32	63	331	271	318	261	308	253	281	231
		8	58	20.2	34	66	635	525	612	507	602	500	576	478
		9	65	28.7	37	68	942	785	908	760	898	751	872	729
		10	59	32.2	39	70	1093	918	1057	890	1048	883	1029	867
		11	42	27.7	42	72	973	822	942	798	936	794	924	784
		12	23	18.1	44	73	645	548	625	533	622	530	616	525
		13	9	8.3	46	74	301	257	292	250	291	249	289	247
		14	2	2.1	48	76	80	68	77	66	77	66	77	66
			345	155.9			5198	4354	5008	4209	4946	4159	4782	4020

ARITH. MEAN DBH= 8.9 , QUADRATIC MEAN DBH= 9.1 , WEIBULL PARAMETERS A= 1.5 , B= 8.14 , C= 4.07
PERCENT SURVIVAL= 57.5 , MEAN CROWN RATIO= 36.7 , LAMBDA= .758
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	ALL TREES GROUND TO TIP I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
30	77	3	1	.0	15	39	1	1						
		4	3	.3	18	49	6	5						
		5	7	1.0	22	57	25	20	23	19	20	16	11	8
		6	15	2.9	25	62	84	73	80	65	75	61	58	47
		7	26	6.9	28	67	216	177	207	171	201	166	183	151
		8	38	13.3	30	70	437	363	422	351	415	345	397	330
		9	47	20.8	33	73	727	608	704	590	696	584	679	570
		10	48	26.2	35	75	961	811	933	789	926	783	913	770
		11	44	29.0	37	77	1031	916	1049	891	1042	886	1029	874
		12	32	25.1	39	79	963	820	935	799	931	795	922	787
		13	18	16.6	41	80	646	552	627	538	625	536	620	532
		14	8	8.6	43	81	337	290	328	283	327	282	325	280
		15	3	3.7	45	82	147	127	143	124	143	123	142	123
		16	1	1.4	47	83	56	49	55	48	55	48	55	47
			291	155.8			5687	4807	5506	4668	5456	4625	5330	4519

ARITH. MEAN DBH= 9.6 , QUADRATIC MEAN DBH= 9.9 , WEIBULL PARAMETERS A= 1.7 , B= 8.74 , C= 3.93
PERCENT SURVIVAL= 48.5 , MEAN CROWN RATIO= 34.2 , LAMBDA= .814
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

YIELDS GIVEN T_P WITH IDEAL SURVIVAL –

T_P 800

S_F 70

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
10	37	1	1	.0	42	13	0	0						
		2	12	.3	47	25	3	2						
		3	56	2.7	51	30	49	32						
		4	139	12.1	53	34	223	156						
		5	203	27.7	55	36	516	376	471	346	421	308	311	222
		6	158	31.0	57	38	594	445	549	416	521	394	448	336
		7	53	14.2	58	39	275	211	256	198	248	192	229	176
		8	6	2.1	60	40	41	32	39	30	38	30	36	28
			628	90.1			1701	1254	1315	990	1228	924	1024	762

ARITH. MEAN DBH= 5.0 , QUADRATIC MEAN DBH= 5.1 , WEIBULL PARAMETERS A= .4 , B= 5.03 , C= 4.46
PERCENT SURVIVAL= 78.5 , MEAN CROWN RATIO= 55.4 , LAMBDA= .248
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	I.B.	2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
15	53	2	1	.0	24	29	0	0						
		3	10	.5	30	38	10	7						
		4	33	2.9	34	44	62	48						
		5	75	10.2	38	48	232	179	215	167	187	144	114	83
		6	123	24.2	41	50	584	462	549	437	521	415	431	339
		7	144	38.5	44	52	980	790	931	754	904	733	838	678
		8	112	39.1	47	54	1043	852	996	818	979	805	938	770
		9	52	23.0	50	55	629	519	603	500	597	495	580	481
		10	13	7.1	52	56	187	151	178	145	176	143	172	140
		11	1	.7	54	57	18	15	17	14	17	14	17	14
			564	146.1			3745	3023	3489	2835	3381	2749	3090	2505

ARITH. MEAN DBH= 6.7 , QUADRATIC MEAN DBH= 6.9 , WEIBULL PARAMETERS A= .8 , B= 6.46 , C= 4.44
PERCENT SURVIVAL= 70.5 , MEAN CROWN RATIO= 43.6 , LAMBDA= .606
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	I.B.	2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
20	62	3	4	.2	21	40	4	3						
		4	15	1.3	25	47	29	23						
		5	36	4.9	29	52	120	95	112	89	97	77	52	[illegible]
		6	66	13.0	32	56	341	275	323	262	306	248	247	198
		7	96	25.7	36	58	714	579	680	555	660	538	611	497
		8	105	36.7	38	61	1082	889	1037	857	1019	842	975	805
		9	90	39.8	41	62	1205	1000	1159	966	1146	955	1113	928
		10	53	28.9	44	64	909	760	876	736	868	730	853	717
		11	20	13.2	46	65	423	357	409	345	406	343	401	339
		12	5	3.9	48	66	128	109	124	105	123	115	122	104
		13	1	.9	50	67	31	26	30	25	30	25	29	25
			491	168.4			4986	4116	4750	3940	4655	3863	4403	3651

ARITH. MEAN DBH= 7.7 , QUADRATIC MEAN DBH= 7.9 , WEIBULL PARAMETERS A= 1.2 , B= 7.21 , C= 4.20
PERCENT SURVIVAL= 61.4 , MEAN CROWN RATIO= 37.7 , LAMBDA= .741
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

YIELDS GIVEN T_P WITH IDEAL SURVIVAL –

T_P 800

S_I 70

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
25	70	3	2	.1	16	40	2	1						
		4	7	.6	20	49	14	11						
		5	19	2.6	23	55	66	53	62	49	54	43	28	21
		6	37	7.3	27	60	202	163	192	156	181	147	140	112
		7	58	15.5	30	64	463	380	445	365	431	355	393	323
		8	76	26.5	32	66	833	689	802	665	789	655	755	627
		9	81	35.8	35	69	1194	997	1154	966	1141	955	1113	933
		10	67	36.5	38	70	1242	1042	1200	1011	1190	1003	1168	985
		11	43	28.4	40	72	996	841	964	817	958	813	946	802
		12	20	15.7	42	73	561	476	544	463	541	461	536	457
		13	6	5.5	44	75	203	173	197	169	196	168	195	167
		14	1	1.1	46	76	40	34	39	33	39	33	38	33
			417	175.6			5816	4860	5599	4694	5520	4633	5312	4460

ARITH. MEAN DBH= 8.6 , QUADRATIC MEAN DBH= 8.8 , WEIBULL PARAMETERS A= 1.4 , B= 7.86 , C= 4.02
PERCENT SURVIVAL= 52.1 , MEAN CROWN RATIO= 33.9 , LAMBDA= .822
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
30	77	3	1	.0	13	40	1	1						
		4	4	.3	17	50	8	6						
		5	10	1.4	20	58	36	29	34	27	29	23	15	11
		6	21	4.1	23	63	119	97	113	92	107	87	83	66
		7	35	9.4	26	68	294	242	282	233	274	226	249	206
		8	49	17.1	28	71	571	474	551	458	542	451	518	431
		9	58	25.6	31	74	908	760	879	738	869	730	848	712
		10	59	32.2	33	76	1195	1009	1161	982	1152	974	1133	959
		11	49	32.3	36	78	1218	1032	1182	1004	1174	998	1159	985
		12	33	25.9	38	80	1004	856	976	834	971	830	962	822
		13	17	15.7	40	81	617	528	599	514	597	512	593	509
		14	7	7.5	42	82	299	256	290	250	290	249	288	248
		15	2	2.5	44	83	99	85	97	83	96	83	96	83
			345	174.0			6369	5375	6164	5215	610[illegible]	5163	5944	5032

ARITH. MEAN DBH= 9.4 , QUADRATIC MEAN DBH= 9.6 , WEIBULL PARAMETERS A= 1.7 , B= 8.48 , C= 3.89
PERCENT SURVIVAL= 43.1 , MEAN CROWN RATIO= 31.7 , LAMBDA= .872
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

YIELDS GIVEN T_P WITH IDEAL SURVIVAL —

T_P 1000

S_I 70

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft^{2}	Pct	Ft	Ft^{3}							
10	37	1	1	.0	37	13	0	0						
		2	22	.5	44	25	6	3						
		3	93	4.6	48	30	70	46						
		4	210	18.3	51	34	338	235						
		5	256	34.9	53	36	651	474	594	436	531	388	392	280
		6	147	28.9	55	38	553	414	511	387	485	367	417	313
		7	31	8.3	57	39	161	123	150	116	145	112	134	103
		8	2	.7	59	40	14	11	13	10	13	10	12	9
			752	96.1			1793	1306	1268	949	1174	877	955	705

ARITH. MEAN DBH= 4.7 , QUADRATIC MEAN DBH= 4.8 , WEIBULL PARAMETERS A= .3 , B= 4.75 , C= 4.42
PERCENT SURVIVAL= 76.2 MEAN CROWN RATIO= 52.6 , LAMBDA= .313
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
15	53	2	2	.0	22	30	1	1						
		3	15	.7	27	39	15	11						
		4	50	4.4	32	45	95	73						
		5	108	14.7	36	48	335	258	310	240	270	208	165	120
		6	165	32.4	40	51	795	630	749	597	710	566	587	462
		7	173	46.2	43	53	1195	965	1136	922	1103	895	1022	828
		8	113	39.4	46	55	1068	874	1021	839	1004	825	961	790
		9	41	18.1	48	56	504	416	483	401	478	396	464	385
		10	7	3.8	51	57	102	83	97	79	96	79	94	77
			674	159.9			4110	3311	3796	3078	3661	2969	3293	2662

ARITH. MEAN DBH= 6.4 , QUADRATIC MEAN DBH= 6.6 , WEIBULL PARAMETERS A= .8 , B= 6.19 , C= 4.40
PERCENT SURVIVAL= 67.4 , MEAN CROWN RATIO= 41.0 , LAMBDA= .666
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
20	62	2	1	.0	14	29	0	0						
		3	6	.3	19	40	6	4						
		4	21	1.8	23	48	42	32						
		5	50	6.8	27	53	169	134	158	126	137	109	73	54
		6	89	17.5	31	57	466	376	442	358	418	339	337	270
		7	122	32.6	34	59	913	745	874	715	848	694	774	634
		8	128	44.7	37	62	1337	1100	1282	1060	1260	1042	1206	996
		9	95	42.0	40	63	1289	1071	1240	1034	1227	1023	1191	994
		10	48	26.2	42	65	834	698	804	676	797	670	783	659
		11	15	9.9	45	66	322	271	311	263	319	261	305	258
		12	3	2.4	47	67	79	66	75	64	75	64	74	63
			578	184.1			5456	4497	5186	4296	5071	4202	4743	3926

ARITH. MEAN DBH= 7.4 , QUADRATIC MEAN DBH= 7.6 , WEIBULL PARAMETERS A= 1.1 , B= 6.97 , C= 4.16
PERCENT SURVIVAL= 57.8 , MEAN CROWN RATIO= 35.3 , LAMBDA= .796
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

YIELDS GIVEN T_P WITH IDEAL SURVIVAL —

T_P 1000

S_I 70

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME — ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
25	70	3	3	.1	15	40	3	2						
		4	10	.9	18	49	20	16						
		5	26	3.5	22	56	91	73	86	69	74	59	39	29
		6	49	9.6	25	60	267	216	254	206	240	195	186	149
		7	75	20.0	28	64	599	491	575	472	557	459	508	418
		8	92	32.1	31	66	1008	834	971	805	956	793	914	759
		9	92	40.6	34	69	1356	1132	1311	1097	1296	1085	1264	1059
		10	72	39.3	36	71	1351	1135	1306	1101	1296	1092	1271	1072
		11	42	27.7	39	72	973	822	942	798	936	794	924	784
		12	17	13.4	41	73	477	405	462	394	460	392	456	388
		13	5	4.6	43	75	169	144	164	141	164	140	162	139
		14	1	1.1	45	76	40	34	39	33	39	33	38	33
			484	193.0			6354	5304	6110	5116	6018	5042	5762	4830

ARITH. MEAN DBH= 8.3 , QUADRATIC MEAN DBH= 8.5 , WEIBULL PARAMETERS A= 1.4 , B= 7.64 , C= 3.99
PERCENT SURVIVAL= 48.4 , MEAN CROWN RATIO= 31.8 , LAMBDA= .872
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME — ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
30	77	3	1	.0	12	41	1	1						
		4	5	.4	15	51	10	8						
		5	14	1.9	18	58	51	40	47	38	41	33	22	16
		6	27	5.3	21	64	155	126	147	120	139	114	107	86
		7	44	11.8	24	68	369	304	355	293	344	284	313	259
		8	60	20.9	27	71	699	580	675	561	664	552	634	528
		9	69	30.5	29	74	1080	904	1046	878	1034	868	1008	847
		10	66	36.0	32	76	1337	1129	1298	1098	1288	1090	1267	1073
		11	52	34.3	34	78	1336	1137	1300	1108	1293	1103	1278	1090
		12	33	25.9	36	80	1004	856	976	834	971	830	962	822
		13	16	14.7	39	81	580	496	564	484	562	482	558	479
		14	6	6.4	41	82	256	220	249	214	248	214	247	213
		15	1	1.2	43	83	50	43	48	42	48	42	48	41
			394	189.5			6928	5844	6705	5670	6632	5612	6444	5454

ARITH. MEAN DBH= 9.1 , QUADRATIC MEAN DBH= 9.4 , WEIBULL PARAMETERS A= 1.6 , B= 8.28 , C= 3.86
PERCENT SURVIVAL= 39.4 , MEAN CROWN RATIO= 29.8 , LAMBDA= .917
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

YIELDS GIVEN T_P WITH IDEAL SURVIVAL —

T_P 1200

S_I 70

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No.	Ft²	Pct	Ft	Ft³							
10	37	1	3	.0	33	13	0	0						
		2	35	.8	41	25	10	5						
		3	141	6.9	46	31	108	71						
		4	286	25.0	49	34	430	309						
		5	292	39.8	52	37	759	553	692	510	619	453	455	326
		6	121	23.8	54	38	455	341	421	318	399	302	343	257
		7	15	4.0	56	40	79	61	74	57	72	55	66	51
			----	------			-----	-----	-----	-----	-----	-----	-----	-----
			893	100.2			1841	1340	1187	885	1090	810	864	634

ARITH. MEAN DBH= 4.4 , QUADRATIC MEAN DBH= 4.5 , WEIBULL PARAMETERS A= .3 , B= 4.51 , C= 4.38
PERCENT SURVIVAL= 74.4 , MEAN CROWN RATIO= 50.3 , LAMBDA= .366
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

15	53	2	4	.1	20	29	2	1						
		3	23	1.1	25	39	22	17						
		4	71	6.2	30	44	133	102						
		5	145	19.8	35	48	455	359	425	337	370	292	209	154
		6	205	40.3	38	51	988	783	930	742	882	703	730	574
		7	192	51.3	42	53	1327	1071	1261	1023	1225	994	1135	918
		8	106	37.0	45	55	1002	820	958	787	942	774	902	741
		9	30	13.3	48	56	368	304	353	293	350	290	340	282
		10	4	2.2	50	57	62	52	60	50	59	49	58	49
			----	------			-----	-----	-----	-----	-----	-----	-----	-----
			780	171.2			4359	3509	3987	3232	3828	3102	3374	2718

ARITH. MEAN DBH= 6.2 , QUADRATIC MEAN DBH= 6.3 , WEIBULL PARAMETERS A= .7 , B= 5.98 , C= 4.36
PERCENT SURVIVAL= 65.0 , MEAN CROWN RATIO= 38.9 , LAMBDA= .715
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

20	62	2	1	.0	13	29	0	0						
		3	8	.4	18	40	8	6						
		4	29	2.5	22	48	57	45						
		5	66	9.0	26	53	223	177	208	167	181	144	96	71
		6	113	22.2	29	57	592	477	561	455	531	431	428	343
		7	148	39.6	33	59	1107	903	1060	867	1028	842	939	769
		8	143	49.9	36	62	1493	1229	1433	1184	1408	1164	1347	1113
		9	97	42.8	39	63	1316	1093	1267	1056	1253	1045	1217	1014
		10	43	23.5	41	65	747	626	721	606	714	600	702	590
		11	11	7.3	44	66	236	199	228	193	227	192	224	189
		12	2	1.6	46	67	52	44	50	43	50	43	50	42
			----	------			-----	-----	-----	-----	-----	-----	-----	-----
			661	198.7			5831	4799	5528	4571	5392	4461	5003	4131

ARITH. MEAN DBH= 7.2 , QUADRATIC MEAN DBH= 7.4 , WEIBULL PARAMETERS A= 1.1 , B= 6.77 , C= 4.13
PERCENT SURVIVAL= 55.1 , MEAN CROWN RATIO= 33.4 , LAMBDA= .841
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

YIELDS GIVEN T_P WITH IDEAL SURVIVAL —

T_P 1200

S_I 70

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME							
							ALL TREES GROUND TO TIP		5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF --					
									2 INCHES		3 INCHES		4 INCHES	
							O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
25	70	3	4	.2	13	41	4	3						
		4	14	1.2	17	49	28	22						
		5	33	4.5	21	56	116	93	109	87	94	75	50	37
		6	61	12.0	24	60	332	269	316	257	298	243	231	185
		7	91	24.3	27	64	727	596	697	573	676	557	617	507
		8	105	36.7	30	66	1150	951	1108	919	1091	905	1043	866
		9	103	45.5	32	69	1518	1267	1468	1228	1451	1215	1416	1186
		10	75	40.9	35	71	1431	1205	1387	1171	1377	1162	1353	1143
		11	40	26.4	38	72	926	783	897	760	891	756	880	746
		12	15	11.8	40	73	421	357	408	347	406	346	402	343
		13	4	3.7	42	75	135	116	131	112	131	112	130	111
		14	1	1.1	44	76	40	34	39	33	39	33	38	33
			546	208.2			6828	5696	6560	5487	6454	5404	6160	5157

ARITH. MEAN DBH= 8.1 , QUADRATIC MEAN DBH= 8.3 , WEIBULL PARAMETERS A= 1.4 , B= 7.46 , C= 3.96
PERCENT SURVIVAL= 45.5 , MEAN CROWN RATIO= 30.0 , LAMBDA= .913
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	ALL TREES I.B.	2 INCHES O.B.	2 INCHES I.B.	3 INCHES O.B.	3 INCHES I.B.	4 INCHES O.B.	4 INCHES I.B.
30	77	3	2	.1	11	41	2	2						
		4	7	.6	14	51	14	11						
		5	17	2.3	17	58	61	49	57	46	50	40	26	19
		6	33	6.5	20	64	189	154	180	147	170	139	131	106
		7	53	14.2	23	68	445	366	428	352	414	342	378	311
		8	70	24.4	26	71	816	677	787	655	774	644	740	616
		9	77	34.0	28	74	1205	1009	1167	979	1154	969	1125	945
		10	73	39.8	31	76	1479	1248	1436	1214	1425	1206	1401	1186
		11	55	36.3	33	78	1413	1203	1375	1172	1367	1166	1351	1153
		12	32	25.1	35	80	1024	879	998	858	994	855	987	849
		13	14	12.9	38	81	508	434	494	424	492	422	488	419
		14	5	5.3	40	82	213	183	207	179	207	178	206	177
		15	1	1.2	42	83	50	43	48	42	48	42	48	41
			439	202.8			7419	6258	7177	6068	7095	6003	6881	5822

ARITH. MEAN DBH= 9.0 , QUADRATIC MEAN DBH= 9.2 , WEIBULL PARAMETERS A= 1.6 , B= 8.12 , C= 3.84
PERCENT SURVIVAL= 36.6 , MEAN CROWN RATIO= 28.2 , LAMBDA= .953
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

YIELDS GIVEN T_P WITH IDEAL SURVIVAL —

T_P 1500

S_I 70

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
Yrs	Ft	In	No	Ft²	Pct	Ft	Ft³							
10	37	1	6	.0	30	12	0	0						
		2	65	1.4	38	24	18	10						
		3	232	11.4	43	30	174	114						
		4	399	34.8	47	34	601	431						
		5	301	41.0	51	36	766	557	698	513	625	457	461	330
		6	76	14.9	53	38	286	214	264	200	251	190	216	162
		7	4	1.1	56	40	21	16	20	15	19	15	18	14
			1083	104.7			1866	1342	982	728	895	662	695	506

ARITH. MEAN DBH= 4.1 , QUADRATIC MEAN DBH= 4.2 , WEIBULL PARAMETERS A= .2 , B= 4.22 , C= 4.34
PERCENT SURVIVAL= 72.2 , MEAN CROWN RATIO= 47.5 , LAMBDA= .431
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
15	53	2	6	.1	18	29	2	2						
		3	36	1.8	23	38	35	26						
		4	107	9.3	28	44	200	154						
		5	205	28.0	33	48	643	507	600	476	523	413	296	218
		6	263	51.6	37	51	1267	1004	1194	951	1132	902	936	737
		7	207	55.3	40	53	1430	1154	1360	1103	1320	1071	1223	990
		8	89	31.1	44	55	841	688	804	661	791	650	757	622
		9	18	8.0	47	56	221	183	212	176	210	174	204	169
		10	1	.5	49	57	16	13	15	12	15	12	15	12
			932	185.7			4655	3731	4185	3379	3991	3222	3431	2748

ARITH. MEAN DBH= 5.9 , QUADRATIC MEAN DBH= 6.0 , WEIBULL PARAMETERS A= .7 , B= 5.71 , C= 4.32
PERCENT SURVIVAL= 62.1 , MEAN CROWN RATIO= 36.3 , LAMBDA= .776
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
20	62	2	2	.0	11	28	1	1						
		3	13	.6	16	40	13	10						
		4	42	3.7	20	48	83	65						
		5	92	12.5	24	53	310	247	290	232	252	201	134	99
		6	150	29.5	28	56	775	624	735	595	695	563	561	449
		7	184	49.2	31	59	1376	1123	1317	1078	1278	1047	1168	956
		8	159	55.5	34	61	1631	1344	1568	1295	1544	1276	1477	1222
		9	94	41.5	37	63	1276	1060	1227	1023	1214	1013	1179	983
		10	34	18.5	40	65	591	495	570	479	565	475	555	466
		11	7	4.6	43	66	150	127	145	123	144	122	142	120
		12	1	.8	45	67	26	22	25	21	25	21	25	21
			778	216.5			6232	5118	5871	4846	5717	4718	5241	4316

ARITH. MEAN DBH= 7.0 , QUADRATIC MEAN DBH= 7.1 , WEIBULL PARAMETERS A= 1.0 , B= 6.53 , C= 4.10
PERCENT SURVIVAL= 51.9 , MEAN CROWN RATIO= 31.0 , LAMBDA= .896
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

YIELDS GIVEN T_P WITH IDEAL SURVIVAL —

T_P 1500

S_I 70

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	CUBIC FOOT VOLUME: ALL TREES GROUND TO TIP O.B.	I.B.	5-INCH CLASS AND GREATER, STUMP HEIGHT .5 FEET, FOR O.B. TOPS OF -- 2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
Yrs	Ft	In	No.	Ft²	Pct	Ft	Ft³							
25	70	2	1	.0	8	28	0	0						
		3	5	.2	12	41	5	4						
		4	19	1.7	16	50	39	30						
		5	45	6.1	19	56	158	126	148	119	128	103	68	50
		6	80	15.7	22	61	442	358	420	342	397	323	307	246
		7	114	30.5	25	65	923	756	885	728	858	707	783	644
		8	130	45.4	28	67	1442	1194	1390	1153	1368	1136	1308	1086
		9	114	50.4	31	70	1701	1421	1645	1377	1626	1362	1587	1330
		10	76	41.5	34	71	1450	1222	1406	1186	1396	1178	1371	1158
		11	36	23.8	36	73	844	713	817	693	812	689	802	680
		12	11	8.6	39	74	312	265	303	258	301	257	298	254
		13	2	1.8	41	76	69	59	66	57	66	57	66	56
			633	225.7			7385	6148	7080	5913	6952	5812	6590	5504

ARITH. MEAN DBH= 7.9 , QUADRATIC MEAN DBH= 8.1 , WEIBULL PARAMETERS A= 1.3 , B= 7.24 , C= 3.93
PERCENT SURVIVAL= 42.2 , MEAN CROWN RATIO= 27.9 , LAMBDA= .963
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

GROWING SEASONS SINCE EST.	AV. D+C HT.	DBH	STEMS PER ACRE	BASAL AREA	CR	AV. HT.	ALL TREES O.B.	I.B.	2 INCHES O.B.	I.B.	3 INCHES O.B.	I.B.	4 INCHES O.B.	I.B.
30	77	3	2	.1	10	41	2	2						
		4	9	.8	13	51	19	15						
		5	22	3.0	16	58	79	64	74	60	64	52	34	25
		6	42	8.2	19	64	241	196	229	187	216	177	167	134
		7	66	17.6	22	68	554	455	532	439	516	426	470	388
		8	85	29.7	24	71	990	822	956	795	940	783	898	748
		9	92	40.6	27	74	1440	1205	1395	1170	1379	1157	1345	1129
		10	80	43.6	29	76	1621	1368	1574	1331	1562	1321	1536	1300
		11	56	37.0	32	78	1438	1224	1400	1193	1392	1188	1376	1174
		12	31	24.3	34	80	992	852	967	832	963	828	956	822
		13	12	11.1	36	81	435	372	423	363	422	362	418	359
		14	4	4.3	39	82	171	147	166	143	166	143	165	142
		15	1	1.2	41	83	50	43	48	42	48	42	48	41
			502	221.6			8032	6765	7764	6555	7668	6479	7413	6262

ARITH. MEAN DBH= 8.7 , QUADRATIC MEAN DBH= 9.0 , WEIBULL PARAMETERS A= 1.6 , B= 7.92 , C= 3.81
PERCENT SURVIVAL= 33.5 , MEAN CROWN RATIO= 26.3 , LAMBDA= .998
CORRESPONDING SITE INDEX FOR BASE AGE 50=102

Feduccia, D. P., T. R., Dell, W. F. Mann, Jr., T. E. Campbell, and B. H. Polmer.

1979. Yields of unthinned loblolly pine plantations on cutover sites in the West Gulf region, U.S. Dep. Agric. For. Serv. Res. Pap. SO-148, 88 p. South. For. Exp. Stn., New Orleans, La.

Detailed tables of trees per acre, basal area, average height, crown ratio, and cubic-foot volumes are presented by 1-inch diameter classes for several combinations of site index, plantation age, and (1) number of trees surviving, (2) number of trees planted and an ideal survival pattern, and (3) number of trees planted and a typical survival pattern.

Additional keywords: *Pinus taeda,* volume predictions, unthinned plantation yields, volume yields of loblolly pine, Weibull distribution, taper curves, crown ratio, survival prediction, problem-free sites.

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Veneer-Reinforced Structural Composition Board

OTTO SUCHSLAND, GEORGE E. WOODSON,
AND SIDON KEINERT, JR.

Southern
Forest
Experiment
Station

Summary

In certain structural applications of particleboard linear expansion might be the critical characteristic. When inexpensive veneer, either single-ply or cross-laminated two-ply, was placed in the center of particleboards, linear expansion was reduced greatly. Linear expansion was somewhat reduced in fiberboards but was affected little in flakeboards. In this scheme board dimensions are not limited by veneer dimensions, and even large open defects would have little effect on board appearance. Press cycles are not limited by the crushing strength of the veneer.

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1979

Veneer-Reinforced Structural Composition Board

OTTO SUCHSLAND, GEORGE E. WOODSON,
AND SIDON KEINERT, JR.

Introduction

The performance characteristics of structural plywood are often used as standards for structural panels made from particles, flakes, or fibers. While most particleboard properties can be varied by raw material and process modifications, it is difficult to elevate all the important properties to plywood levels without exceeding plywood prices.

Modulus of elasticity in bending (MOE) and linear expansion (LE) are two important properties of structural panels (fig. 1). But when veneer faces are used to lower LE and increase MOE of particleboard, it is either expensive or the size of the veneer faces produces severe size limitations on the particleboard. Since stiffness ($E \cdot I = E \frac{b \cdot h^3}{12}$) is more important than MOE, an increase in thickness (h) would be more profitable than trying to improve the MOE by other methods. A 25 percent increase in thickness doubles the stiffness of particleboard. This approach, of course, has been recognized and proposed before.

To reduce LE requires either large flakes or orientation. The cheapest orientation of wood fibers is found in low-grade veneer. For expansion restraint, the most efficient use of veneer is in the center where balancing is not required and where continuity is not essential. This paper reports results of a cooperative effort between Michigan State University, and the Southern Forest Experiment Station, Forest Service—USDA, Pineville, Louisiana, in which preliminary tests were conducted of composites with veneer cores.

Design of Experiment

A number of small boards (16 inches by 20 inches) were fabricated in the laboratory with different constructions and with three different furnishes (table 1). All boards were pressed to 3/4 inch thickness with the exception of the 5-ply plywood, which was 1/2 inch thick. A two-component resin (Allied Chemical Fiberbond Binder)[1] was used in the fiberboards, and typical particleboard urea resin was used in the particleboard, flakeboard, and plywood. Resin was applied to the core veneers with a small brush. The sweetgum fiber furnish was produced in a Bauer 418 pressurized refiner. The southern pine planer shavings were obtained from a Louisiana particleboard manufacturer, and the sweetgum flakes were produced on a Koch Shaping Lathe. The number of replications was three.

The following tests were performed:

a) Linear expansion (LE) in both directions (47 to 93 percent R.H.). Method: Optical comparator (see Suchsland 1970).

b) Modulus of elasticity in bending (MOE) in both directions (47 to 93 to 47 percent R.H.). Method: Transverse vibration of small beams.

c) Thickness swelling (TS) (47 to 93 to 47 percent R.H.). Method: 3/4 inch cubes conditioned in desiccators.

d) Internal bond (IB) (47 to 93 to 47 percent R.H.). Method: Compression-shear test (see Suchsland 1977).

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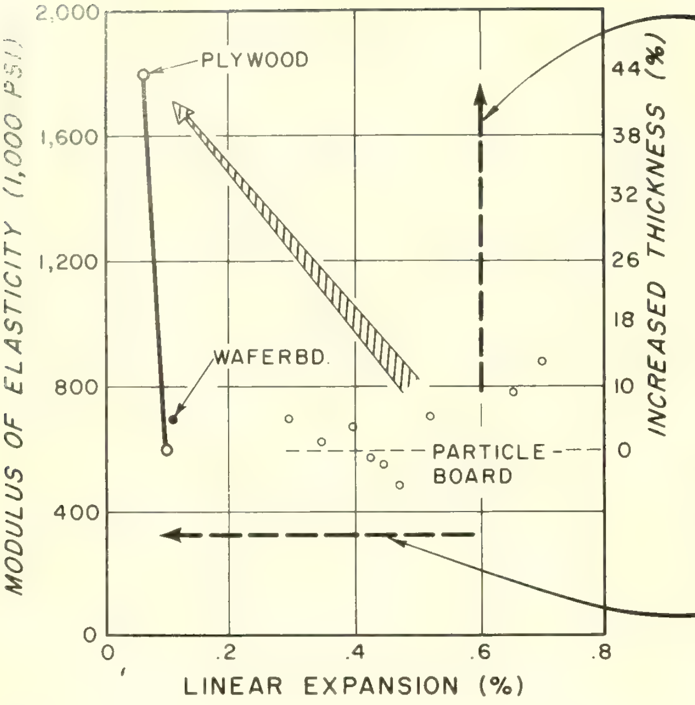

MOE IMPROVEMENT

METHOD	LIMITATION
ORIENTATION PARTICLES VENEER	HIGHER COST SIZE LIMITATION
HIGHER RESIN CONTENT	HIGHER COST
HIGHER DENSITY	HIGHER COST, INSTABILITY
INCREASED THICKNESS	MODERATELY HIGHER COST

LINEAR EXPANSION IMPROVEMENT

LARGE FLAKES	LOW YIELD, RAW MATERIAL LIMITATION
ORIENTATION PARTICLES VENEER	HIGHER COST NONE

Figure 1.—*Relationship between MOE and LE of various composition boards. The tabulation lists various methods by which this relationship could be improved for particleboard. Plywood is represented by two points, which account for the effect of the grain direction of the face veneers. Commercial particleboards are represented by the points in the lower right.*

Table 1.—*List of furnishes, constructions, and board densities used in experiment*

	Construction	Resin content	Single veneer core		2-ply core	Control	
						No veneer	5-ply plywood
	Veneer thickness	—	1/10"	1/8"	1/10"	—	1/10"
			g/cm^3				
Furnish	S.P. Planer shavings (particleboard)	6.5%	.79	.80	.79	.77	.74
	Sweetgum fiber (fiberboard)	10.0%	.79	.77	.78	.80	—
	3" Sweetgum flakes (flakeboard)	6.5%	.80	.77	.80	.80	—

Results

The expansion of the control particleboard (no veneer core) was close to 0.5 percent in all directions (fig. 2). Southern pine veneer expanded about 0.04 percent in the direction of the grain and about 3.4 percent across the grain. The expansion of 5-ply plywood was about 0.06 percent in the direction of the face grain and close to 0.1 percent in the direction of the core grain.

The restraining effect of the veneer core on the particleboard was remarkable. A two-ply veneer center reduced the expansion in both directions to approximately 0.2 percent, a 60 percent reduction. The single-ply veneer center reduced expansion in the grain direction to about 0.12 percent, a reduction of 75 percent. In the other direction the expansion increased slightly.

With the fiber furnish, the veneer core also reduced LE (fig. 3). However, the control, which had no veneer core, had a low LE to begin with. The expansion of only 0.2 percent is not representative of commercial medium-density fiberboard, which has an LE of about 0.4 percent, but is typical of such boards when produced in the laboratory. Flakeboard did not require LE restraint (fig. 4).

Inclusion of a veneer core had no significant effect on MOE. Compared with the other boards, flakeboard was unstable, a shortcoming associated with very large flakes (fig. 5). Thickness swell of flakeboard was also much greater than TS of the other boards (fig. 6). On the other hand, the IB of the flakeboard was high initially and was only moderately reduced after one high-humidity cycle (fig. 7).

When projected to commercial scale, the use of particleboard with a veneer core offers several advantages besides reduced LE. Such boards would allow efficient utilization of low-grade veneer of many sizes (fig. 8). Even large core defects like knot holes, splits, and gaps would automatically be filled with fiber or particle furnish. Perhaps most important of all, the inclusion of veneer cores may not increase manufacturing costs.

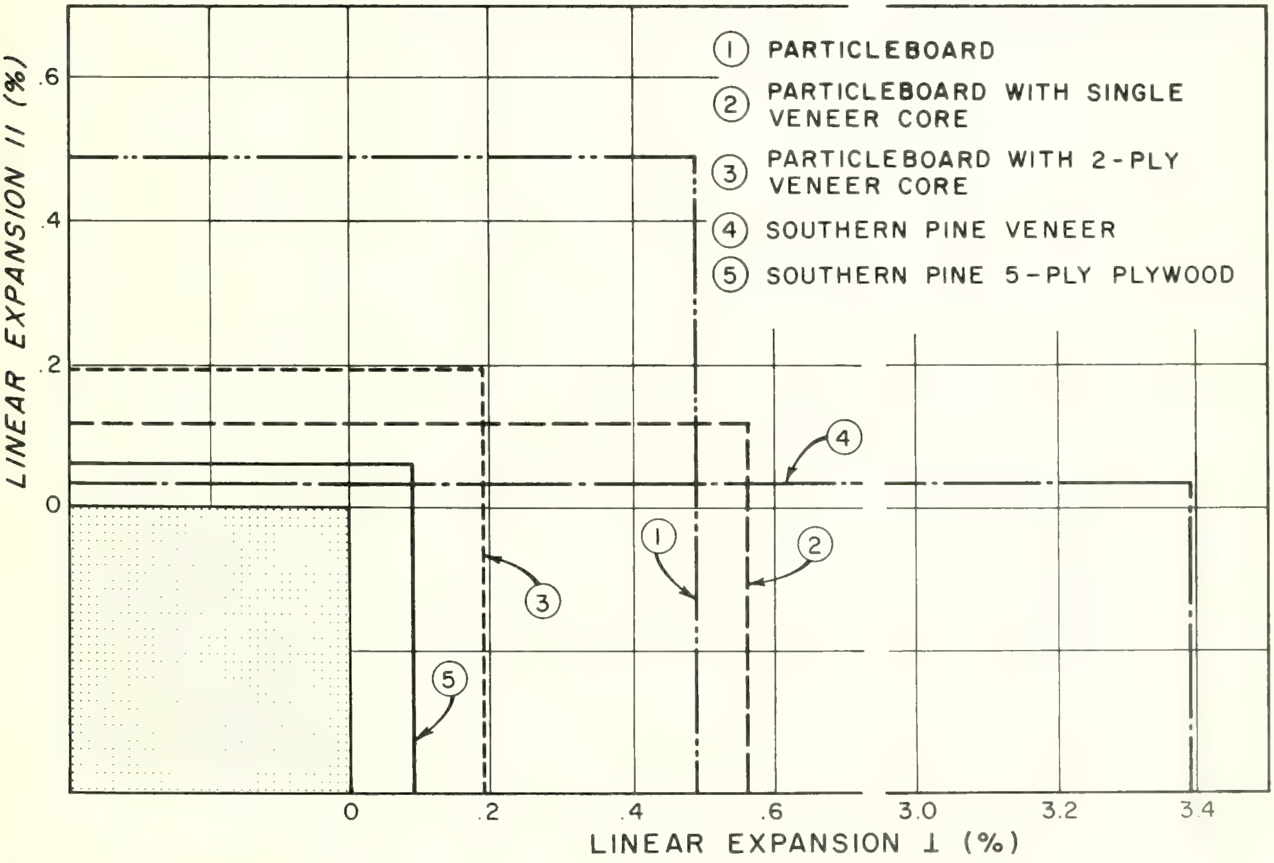

Figure 2.—*Linear expansion of various particleboard constructions compared with southern pine veneer and southern pine plywood.*

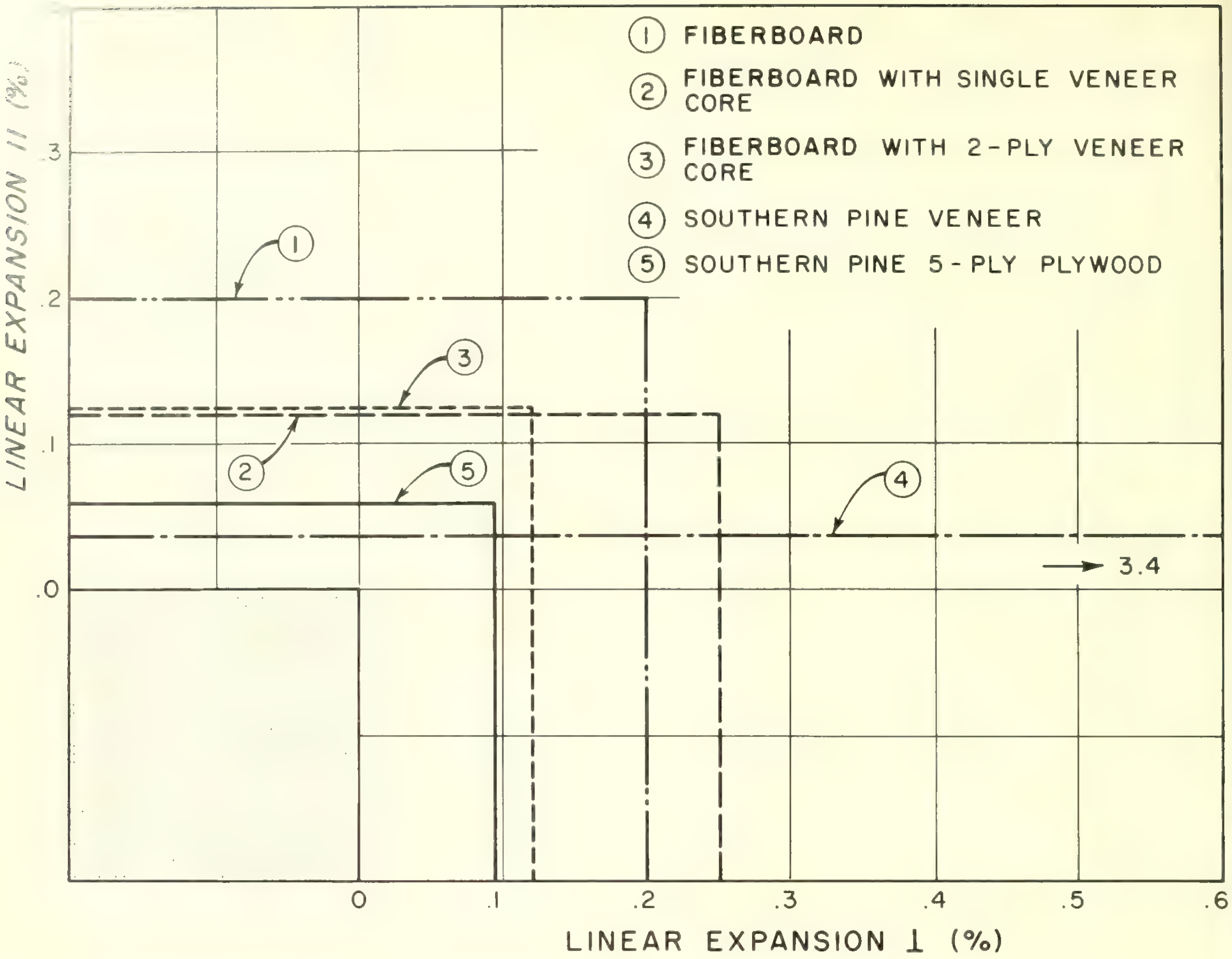

Figure 3.—*Linear expansion of various fiberboard constructions compared with southern pine veneer and southern pine plywood.*

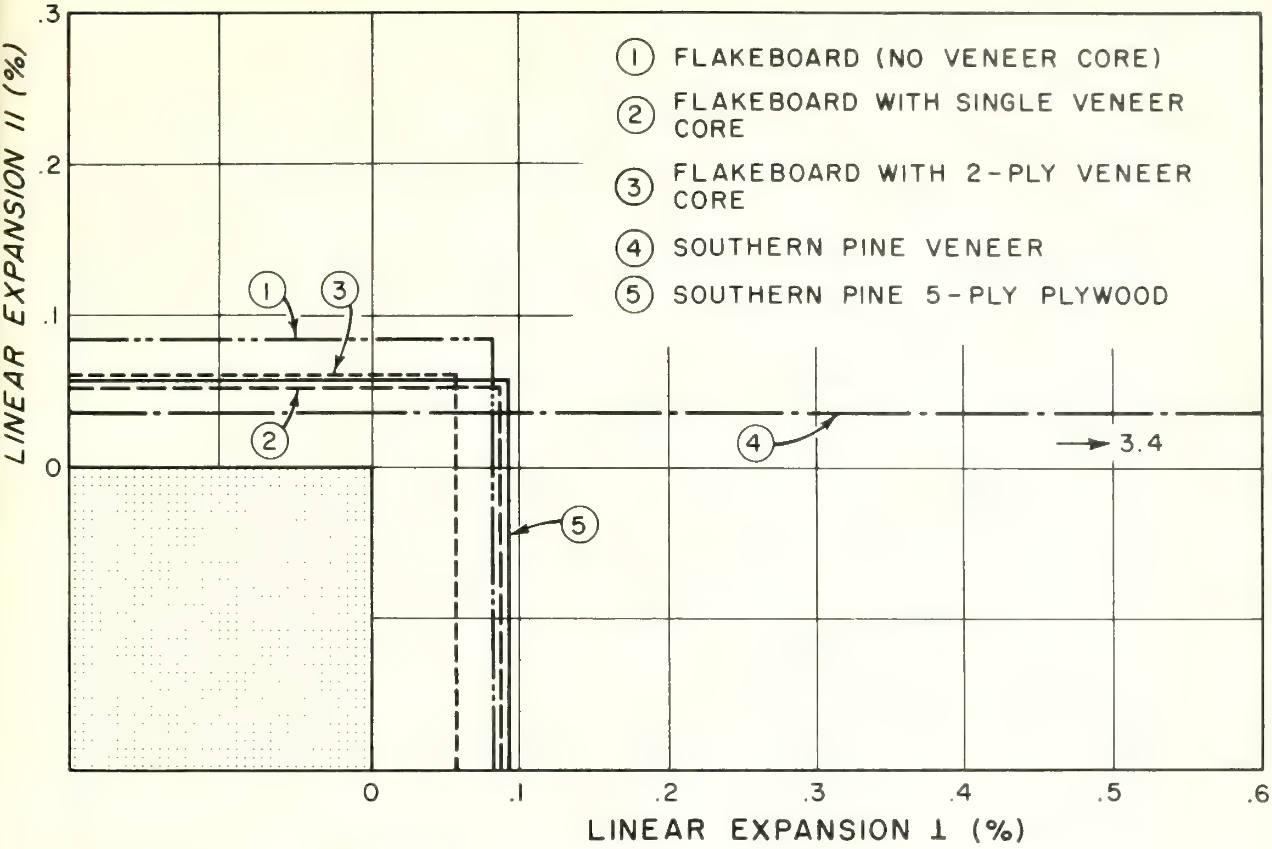

Figure 4.—*Linear expansion of various flakeboard constructions compared with southern pine veneer and southern pine plywood.*

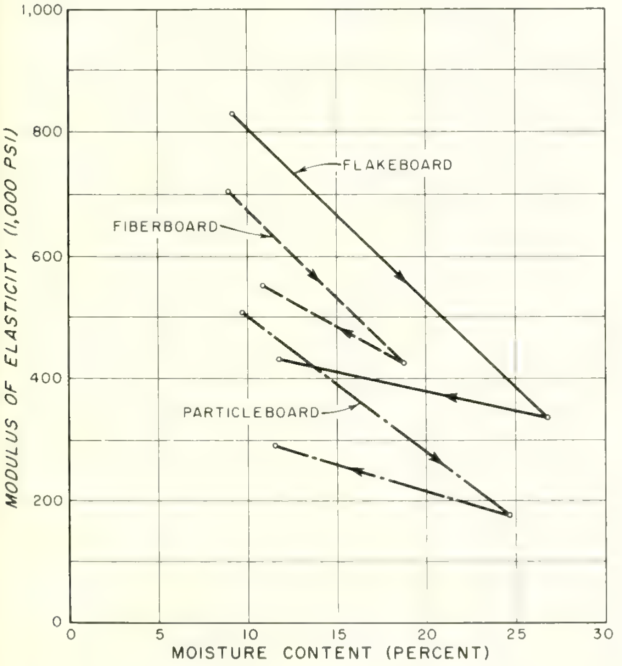

Figure 5.—*Modulus of elasticity in bending of particleboard, fiberboard, and flakeboard as affected by one high-humidity exposure cycle.*

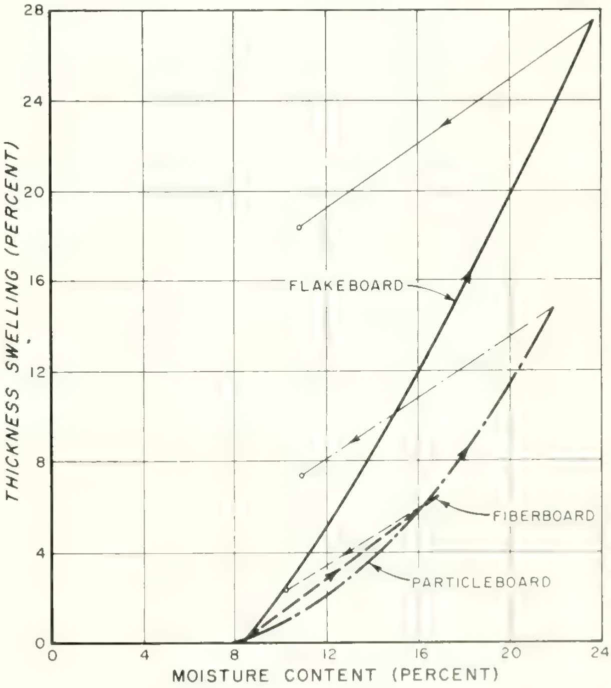

Figure 6.—*Thickness swelling of particleboard, fiberboard, and flakeboard during one high humidity exposure cycle.*

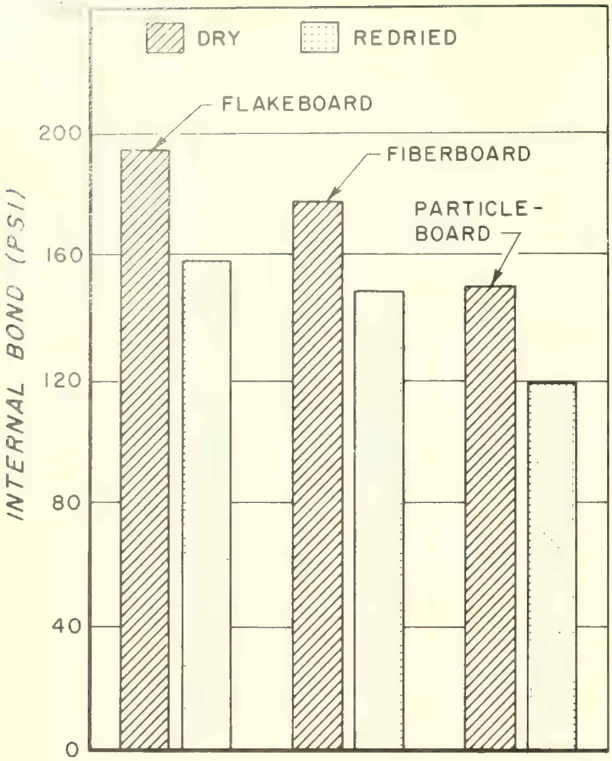

Figure 7.—*Internal bond of particleboard, fiberboard, and flakeboard before and after exposure to high humidity followed by reconditioning.*

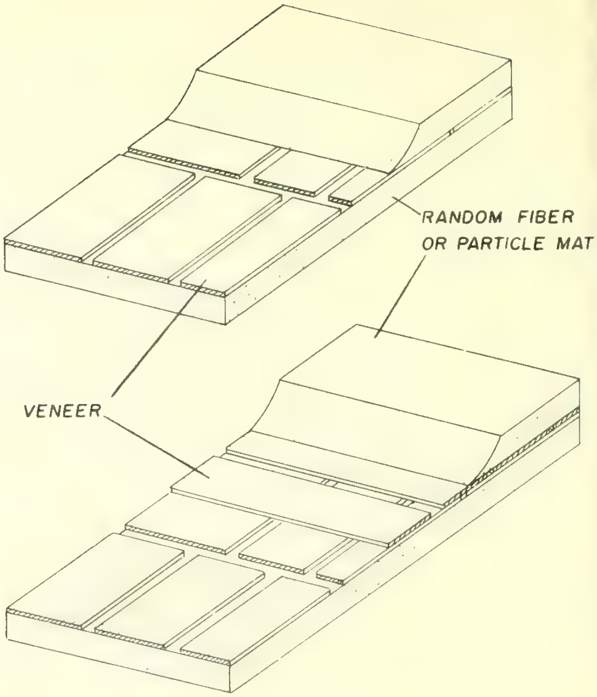

Figure 8.—*Principle of manufacture of composition board with single-ply and two-ply veneer reinforcement.*

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1970. Optical determination of linear expansion and shrinkage of wood. For. Prod. J. 20(6): 26-29.

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1979. Veneer-reinforced structural composition board. U.S. Dep. Agric. For. Serv. Res. Pap. SO-149, 6 p. South. For. Exp. Stn., New Orleans, La.

Describes effects on linear expansion when inexpensive veneer was placed in the center of particleboard, fiberboard, and flakeboard.

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Southern Woods-Burners: A Descriptive Analysis

M. L. DOOLITTLE AND M. L. LIGHTSEY

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SUMMARY

About 40 percent of the South's nearly 60,000 wildfires yearly are set by woods-burners. A survey of 14 problem areas in four southern States found three distinct sets of woods-burners. Most active woods-burners are young, white males whose activities are supported by their peers. An older but less active group have probably retired from active participation but act as patriarchs of the burning community. A small group whose actions are generally disapproved of by the community and who are suspected of other illegal acts complete the major categories of woods-burners. To design fire prevention programs, planners need to keep in mind that most woods-burning is supported by the community. The isolation of rural communities will require opening of new channels of communication before prevailing attitudes can be changed.

ACKNOWLEDGMENTS

The research reported in this paper was performed under terms of cooperative agreements between the Southern Forest Experiment Station and the Mississippi Agricultural and Forestry Experiment Station and the Louisiana Agricultural Experiment Station. Dr. A. W. Baird and Dr. Q. A. L. Jenkins served as principal investigators for the Mississippi and Louisiana stations, respectively.

The detailed study planning, field work, data analysis and report preparation were done by graduate assistants Dale Fox, Jim Hoover, Charles Tekippe, Fred Wanger, Wade Ward, and Stan Weeber. Also, we owe thanks to the numerous employees of the public and private forestry agencies whose willing cooperation made the research possible.

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Southern Woods-Burners: A Descriptive Analysis

M. L. DOOLITTLE AND M. L. LIGHTSEY

Between 1966 and 1975, an average of 59,558 wildfires per year burned an average of 946,231 acres per year in the South.[1] These figures represent 55 percent of the nation's wildfires and 22.5 percent of the total area burned on slightly less than 20 percent of the total forest area under organized fire protection.

About 40 percent of the South's wildfires are classified as incendiary, which means that they were started deliberately without the property owner's permission. These 24,000 fires per year (80 percent of the nation's incendiary occurrence) account for over half the South's acreage loss to fire and consume roughly 350 million ft^3 of wood each year. The proportions of the incendiary problem have changed very little in the past 25 years.

The Southern Forest Experiment Station's fire prevention research work unit at Starkville, Mississippi, has been examining the incendiary fire problem for more than a dozen years. Initially, our study of incendiary fire in the South consisted of sociological surveys of residents of areas (usually counties) with high rates of incendiary occurrence. The results of this phase of research are summarized by Bertrand and Baird (1975). The research in the second phase, which is reported here, focused upon specific fire problem areas and woods-burners themselves.

Incendiary Problem Areas

Incendiary fires occur in clusters or concentrations, ranging from less than 1 mi^2 to perhaps 150 mi^2 or more (Doolittle 1978). Incendiary problem areas studied in this phase of the research process were chosen because they met several requirements:

(1) The problem had existed for at least 5 years.

(2) Fires were particularly disruptive because of number, values protected, hazard, control difficulty, etc.

(3) A reasonable probability existed for application of a successful fire-reduction effort.

(4) Local fire control agency personnel were willing to cooperate fully.

Fourteen incendiary problem areas were examined during the course of the research. Located in four States, the areas each contained about 36,000 acres and averaged about 50 incendiary fires per year.[2] All areas were in the Gulf Coastal

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[1] Data are from annual reports, *Wildfire Statistics* (*Forest Fire Statistics* prior to 1968) prepared by the Cooperative Fire Protection Staff Group, State and Private Forestry, Forest Service, U.S. Dep. of Agric. Figures are for protected Federal, State, and private lands in Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia.

[2] The standard way of expressing fire occurrence is the number of fires per one million acres, called the fire occurrence rate (F.O.R.). The F.O.R. for the average problem area was about 1,390 ($50 \div 36{,}000 \times 1{,}000{,}000$). By contrast, the F.O.R. for the four States wherein the problem areas were located was 177 for a comparable period, and in the counties containing the problem areas it was about 1,140. (Data from *Wildfire Statistics*, 1971-76, and Doolittle, 1977).

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Plain except two, which were in the Appalachian Plateau region.[3] Four problem areas were totally or partially inside a National Forest boundary. The remainder consisted entirely of privately owned lands.

Field Methods

We adopted a standard research design that is best described as a case study approach utilizing observation and interviewing (Dean and others 1967). We established five data categories to guide the field investigator in data collection: (1) the nature of the fire control agency, (2) the nature of the local social organization, (3) the characteristics of victims of incendiarism, (4) the characteristics of residents, and (5) the characteristics of incendiarists. The broad categories were expanded into nearly 50 subcategories.

In close collaboration with the appropriate fire control agency, we selected the general area (county, for example) for a study and assigned a field investigator. The investigator usually was a graduate research assistant with academic training in either forestry, sociology, or both. Before making the final selection of a problem area or areas, the investigator spent several days consulting local fire control agency personnel. Officials of agricultural agencies such as the Cooperative Extension Service and Soil Conservation Service were contacted also during this initial period in the study area.

In preliminary interviews with agency personnel, investigators acquired a list of key contacts in the study area and made a rough delineation of the boundaries of local rural communities. These boundaries were checked during subsequent interviews with residents and adjusted as appropriate. Interviewing within the rural communities began with the key contacts. Besides supplying information about the problem itself, these initial respondents suggested others who could contribute information. This technique was used in selecting respondents until subsequent interviewing yielded only corroborative information. Nearly 600 persons were interviewed.

Data Analysis

The raw data from the field investigations consisted of hundreds of pages of notes, most written immediately after an interview. Initial analysis of these data began in the field, as the investigator placed information from each interview into the appropriate categories.

After leaving the field, the investigator subjected the notes to a form of content analysis (Costner 1965, Selltiz and others 1964). The primary objective of data analysis was to develop a composite picture of woods-burners themselves—those individuals identified either by name or by characterization as people who set fires in the woods without proper authorization.

Characteristics of Woods-Burners

Most residents interviewed claimed to know or suspect the identity of one or more woods-burners; a few identified them by name. Six convicted incendiarists and six other persons who admitted to fire-setting were included among respondents. We found that characterizations of woods-burners were amazingly consistent.

Personal Characteristics[4]

Most active woods-burners identified in this research were young, white males. Most were in their early to mid-twenties, were married, and had either finished high school or dropped out within 2 or 3 years of graduation. Most were unemployed or employed part-time. Practically all had lived in the same area since birth except for brief absences, usually for military duty. The overall level of living of most woods-burners was quite low by national or regional middle-class standards, but only slightly below average by local standards.

A second group of woods-burners we identified may be more numerous than the first group, but are not as active. They are also white males, but are older (those specifically identified averaged 46 years), not as well educated (a reflection of the larger population of that age), and generally enjoy a higher standard of living than the younger group. These older woods-burners probably have retired from active participation, act as the patriarchs of the burning community, and help to perpetuate the woods-burning custom.

A third group of woods-burners were characterized by respondents as no-account, lower-class, social outcasts, a conception of woods-burners commonly held by fire control agency personnel. Some of these burners had been in trouble with the law for various illegal acts and were looked upon with disfavor by most of their neighbors. Their personal characteristics are too variable to permit further characterization.

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[3] The location of these physical divisions can be found in A Forest Atlas of the South (USDA Forest Service) 1969, p. 5.

[4] A more detailed description of the personal characteristics of over a hundred woods-burners may be found in Dunkelberger and Altobellis, 1975.

Few formal organizations existed in the communities we studied, and woods-burners did not belong to the few that did. The church was the only exception, and only about half the younger burners attended its services. The older group was somewhat more active in organizations. But rural residents as a whole are non-joiners, so formal organizations are poor media for communication with them.

The younger group of woods-burners bordered on being loners, associating only with members of their immediate family or one or two close friends. Their favorite pastime appeared to be hunting, either alone or with only one or two friends. Some hunted deer as members of larger, informal confederations, but none belonged to formal clubs or sportsmen organizations. In fact, some resented such groups because of the perceived unfair advantages they gain in hunting leases and expensive equipment.

In most instances, woods-burners were not harshly regarded by other members of the community. For example, in one study involving four communities the investigator recorded 56 responses by residents regarding woods-burners. Thirty (54 percent) were favorable, and 26 were unfavorable. But 13 of the 26 unfavorable comments came from residents of one community where the woods-burners in question were strongly suspected of being involved in car theft, drug trafficking, and other felonious activities. This left only 13 negative responses scattered throughout the other three communities.

Attitudes and Beliefs

Regarding Woods-Burning. The woods-burners we interviewed were unanimous in their belief that fire is essential in man's treatment of the forest. The desirable frequency of its application was reported to be from 1 to 3 years. According to the woods-burners, fire has several benefits:

1. Clear undergrowth—thick underbrush is seen as a threat because it is unattractive and provides fuel for a potentially large and damaging fire, a habitat for forest pests (ticks, red bugs, snakes), and a nuisance to hunters.

2. Eliminate pests—fire is believed to consume the pests themselves as well as their habitat.

3. Facilitate wildlife and cattle management—fire, it was reported, greens the grass, puts tender shoots on shurbs for deer, causes pine mast (seed) to fall for quail and turkey, and enhances growth of certain legumes upon which quail feed.

4. Facilitate timber management—fire is believed beneficial in preparing the ground for seed fall, controlling certain tree diseases, and killing the pine beetle.

Woods-burners are ambivalent about incendiarism. Most are fully aware of the illegality of the act and about half even assessed the usual penalties as fair. However, they feel justified in the practice because they believe that the community supports woods-burning and only fires that damage or destroy valuable property should be illegal. Both beliefs are shared by most residents of incendiary problem areas.

Regarding the first belief, woods-burners and many other residents expressed the view that most local landowners want fire in their woods periodically. (Some landowners confirmed this desire.) Other owners, like the government, corporations, and absentee individuals, simply do not recognize the benefits of fire and so do not burn their woodlands or do so too infrequently. Some people even think that woods-burners are performing a valuable service for these landowners and should not be punished.

The second basic belief distinguished clearly between harmful and beneficial fires. Harmful fires destroy houses, barns, and mature trees, but beneficial fires produce one or more of the beneficial effects described. Harmful fires often are associated with other unlawful acts, like car theft and whiskey making, of a few individuals or are acts of vengeance; beneficial fires are started for practical, functional reasons.

Regarding Forest Landowners. We encountered a wide range of attitudes toward ownership and management of forest land. The traditional tendency to regard the forest as free and open still exists in most areas we examined, so regulations and practices that impede free entry and use are met with resentment and, at times, retaliation by the offended residents. In general, the more restrictive the practices of a landowner, the more likely that his land will be burned—although the fires usually are intended to be more irritating than destructive. Corporate landowners are perceived as most restrictive and government as least restrictive with individual owners falling somewhere in between.[5]

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[5] The relationship between class of ownership and incendiary fire occurrence rate was as expected in a recent survey of 77 fire problem areas; corporate land was highest followed by absentee private and other private. (Doolittle 1978).

The Forest Service is the only government landowner represented in the areas we studied. It apparently ranks highest as a landowner/manager for two central reasons: (1) use of national forests—particularly for hunting—generally is less restricted than use of private lands; and (2) the Forest Services hires local residents but corporations rarely do. This is not to say that the Forest Service is looked upon with favor by all. In fact, 80 percent of the woods-burners and half of all respondents opposed some of the agency's policies or practices.

Specific actions that alienate residents from the Forest Service are closing woods roads, restricting or regulating livestock grazing, developing recreation areas around community swimming holes, charging for fire suppression on private land, managing timber in a way thought to be detrimental to wildlife, and threatening and fining individuals for dumping trash on national forest land. However, the overwhelming general gripe against the Forest Service was that the district ranger and his staff (the "office people") never come around to visit and explain what the Forest Service is doing and why. If there is contact between a resident and an official of the agency, it either is initiated by the resident or its purpose is to censure a resident for some wrong-doing. Woods-burners are more nearly unanimous in this assessment of the Forest Service than are other residents, but the number of comments regarding infrequent and impersonal contacts is simply too large to ignore.

As noted already, the corporations and the individual landowners fared worse than the Forest Service on the landowner prestige scale. Many of the owners of large tracts live outside the communities and, as far as the residents know, rarely come around. Thus, this landowner group is somewhat enigmatic, and their treatment by woods-burners varies depending upon the woods-burners' perception of each owner.

The landowning corporations (usually large wood-using companies) are considered the most restrictive and impersonal of all landowners. Rarely does a resident know or have contact with a company employee.[6] To many residents of fire problem areas the profitmaking emphasis of large companies translates into exploitative practices. The corporations seem to have everything the residents do not: wealth, power, influence, control. Practically the only kind words field investigators heard about the companies pertained to their prescribed burning practices. In this area of management, companies generally are regarded as superior to other landowners because they burn more.

Although the States owned no forest land in the areas we studied, the State forestry agencies certainly are important, even central, elements in the wildfire situation. All forest landowners except the Federal government rely heavily upon the State agencies for prevention, detection, and suppression of fire. Also, most State agencies offer a hazard-reduction burning service to individual landowners on a fee basis. We found that, in general, State forestry agencies are highly regarded by most residents of problem areas—including woods-burners. In fact, some residents of fire problem areas feel sympathetic toward the State agency because many fires it has to fight are started because of antipathy for the landowner, not the State. Only rarely were "dislike for the State agency" or "to see the State employees work" mentioned as motives for woods-burning.

The most likely reasons for the relatively high regard for State agencies are (1) they employ local residents and (2) they are engaged in fewer controversial activities than the forest landowners. In most instances, State lookouts and fire crewmen were people whom local residents knew and visited with informally on occasion. The image that residents—woods-burners and non-burners alike—have of the State agency normally is based upon whether or not they like the employees they know.

As far as residents of fire problem areas are concerned, the State forestry agency is only a fire-fighting outfit. Even those few residents who are aware that the agencies are capable of providing other forestry services state that they do nothing but fight fire.[7] Practically all negative comments made about an agency's activities related to fire suppression: cutting fences to gain access to a fire, causing erosion by plowing deep fire lanes, charging landowners for suppression, etc. Residents are generally unaware of any kind of fire prevention activity in these areas.

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[6] This is indicative of the fact that corporations seldom employ local residents. In one instance where two corporations owned considerable acreages in the area, one employed a local resident while the other did not. The first corporation was held in higher esteem and experienced fewer fires than the second.

[7] In view of the many fires that occur in the areas we studied, this perception often was accurate.

Motives for Woods-Burning

Researchers and other investigators have been asking why people set fire for at least 50 years, and the answers have changed little: grazing, grudge, hunting, jobs, meanness, pests, retaliation. We heard these and more during the course of this research. The twelve woods-burners identified by name illustrate: five had burned to clear the woods of pests and undergrowth; two attributed their burning to hunting; one indicated that mischief was the reason he set a fire; one claimed that his burning resulted from a conflict with the Forest Service; one was a seasonal member of a fire suppression crew at the time he set a fire; two denied (in court and to our investigator) having set the fire for which they had been convicted, but people in the community speculated that they had done it for a cattleman.

Although it was not unusual to hear the full range of motives in a study area, each area had its leading two or three. These leading motives often changed from community to community, but in all cases, the reason related by an actual burner conformed with one of the leading motives stated by his neighbors. Also, there was evidence that a motive can change to fit the situation. In one area where a stock law was being vigorously enforced for the first time, hunting had replaced grazing as a leading motive for burning.

Conclusions

Two general conclusions about woods-burners and their environment can be derived from the descriptions we have presented.

Most Woods-Burning is Normative Behavior

Most woods-burners encountered or described by others during these investigations were acting out roles that to them are completely justified by local standards. These *normative burners* consist of two subtypes; *active burners* and *passive burners,* whom we have already described. The rural communities where the normative burners live are isolated pockets of traditionalism orientated toward the past and the status quo; change is resisted. The family and informal social groups are the major agents for teaching cultural skills, so children form their basic beliefs about fire quite early. These beliefs are continually reinforced by the frequent demonstration that fire has desirable effects. Although not all residents of these communities will actually set fires, most will condone the woods-burning done by others. Only when fires are destructive by community standards or are set by undesirable, *deviant burners,* will local opinion be on the side of landowners and protection agencies.

Rural Residents Are Socially Isolated From Forestry Agencies

Open, active, two-way communication between woods-burners or their neighbors and officials of forestry agencies (public and private) are, for all practical purposes, non-existent in the areas we studied. When the agency has a grievance (a fire, for example), its contact with the resident involved is official, formal, and final. Conversely, when a resident has a gripe (a woods-road closed, for example), he has no authority, no convenient communication channel, and no appeal. So residents feel powerless, for they perceive that they have no control over the environment in which they live. Most of these people express their frustrations verbally only; a few retaliate with actions—a fire, an act of vandalism, perhaps a game law violation. However, the acts of these few are supported by the majority.

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1979. Southern woods-burners: a descriptive analysis. U.S. Dep. Agric. For. Serv. Res. Pap. SO-151, 6 p. South. For. Exp. Stn., New Orleans, La.

Describes three groups of woods-burners identified in a survey of 14 fire problem-areas in the South. Also explores prevailing attitudes toward woods-burning in these rural communities.

Additional keywords: fire-concentrations, incendiarism, prevention.

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TREE GROWTH IN SEVERAL TROPICAL FORESTS OF PUERTO RICO

PETER L. WEAVER

Southern
Forest
Experiment
Station

SUMMARY

About 2400 individual stems ⩾ 4.1 cm d.b.h., and representing about 100 species, from six plots in three Life Zones, some with edaphic variation and/or silvicultural treatment, scattered throughout Puerto Rico, were studied for varying periods, usually ranging from 24 through 30 years but in one instance for only 2 years. Also, more than 11,000 mangrove stems ⩾ 1 cm at ground level were followed after clearcutting on 3 plots consisting of two separate treatments and a control.

The periodic annual increment for all stems ⩾ 4.1 cm, regardless of species or crown class, ranged from about 0.05 cm/yr in the Guánica dry limestone forest of the southwest (Subtropical Dry Life Zone) to about 0.45 cm/yr in the Piñones mangrove and early secondary rainforest at Saint Just, both in Subtropical Moist Life Zone.

The species diversity of forests in Puerto Rico is intermediate between those of continental temperate forests of the United States and continental tropical forests. Ten species accounted for 70 to 95 percent of the stems on all sites, exclusive of Piñones mangrove and Guánica.

RESUMEN

Alrededor de 2400 tallos individuales ⩾ 4.1 cm d.a.p., localizados en 6 parcelas en 3 Zonas de Vida, y representando unas 100 especies, algunos de ellos en parcelas con una variación edáfica y/o tratamiento silvícola, fueron estudiados por períodos variables fluctuando entre 24 a 30 años, aunque en una ocasión por sólo 2 años. Además, después de limpiar 3 rodales consistentes de 2 tratamientos diferentes y un control, se estudiaron la regeneración de 11,000 tallos de mangle ⩾ 1 cm a nivel del suelo.

El incremento periódico anual del d.a.p. (IPA) para todos los tallos ⩾ 4.1 cm, haciendo caso omiso de la especie y clase de copa, fluctuó desde 0.05 cm/año en el bosque seco de piedra caliza de Guánica en el sudoeste de Puerto Rico (Zona de Vida Seca Subtropical) hasta 0.45 cm/año en el manglar de Piñones y el bosque pluvial secundario en St. Just, ambos en Zona de Vida Húmeda Subtropical.

La diversidad de especies en Puerto Rico intermedia entre las de los bosques templados continentales de los Estados Unidos y los bosques tropicales continentales. Diez especies respondieron por el 70 al 95 por ciento de los tallos en todos los sitios, sin contar el mangle de Piñones y el bosque de Guánica.

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1979

Tree Growth in Several Tropical Forests of Puerto Rico

PETER L. WEAVER

INTRODUCTION

From 1943 to 1951, the staff of the Institute of Tropical Forestry established plots in several forests throughout Puerto Rico to determine periodic annual d.b.h. increment (PAI) and to evaluate the potential of different species and forest types for timber production. Initial results disclosed that d.b.h. growth was comparable to that of temperate forests. Subsequently, many of the studies were discontinued after 5 or 10 years.

Since little is known about long-term PAI, stand changes over time, or stand diversity in tropical forests, and since this information is vital to forest planning and management, the plots were remeasured during the mid-70's.

The principal purpose of this paper is to summarize PAI's by species and crown class for several modified or natural stands in Puerto Rico. Also, baseline data on rates of ingrowth, mortality, and stand diversity are provided. Such information will serve as a standard for comparison with other tropical and temperate zone forest types, and with the results of future research in secondary forests of Puerto Rico.

THE STUDY AREA AND RESEARCH PLOTS

Puerto Rico is located at 18°N latitude and 66°W longitude in the West Indies archipelago. It is about 165 km long by 55 km wide and has a highly diverse physical environment (Pico 1950).

The island comprises a central mountain range that is oriented east to west and varies from 600 m to over 1200 m in elevation. The northern foothills and northern coastal lowlands encompass a large region of limestone origin in which karst hills are the dominant land form. Limestone is also found in the southwestern coastal region.

The island receives an average of 1900 mm/yr of rainfall, mostly orographic, with marked differences in amount over short distances. The southwest, or leeward coastal areas, receive about 800 mm/yr; the northeast, east and southeast, or windward coastal areas, about 1500 to 2000 mm/yr. In the mountains, rainfall varies with location, gradually increasing with elevation to over 5000 mm/yr.

Surrounding ocean temperatures vary from 25.5°C to 27.8°C seasonally, and as a result, mean air temperatures have a small range between the warmest and coldest months. Potential evapotranspiration is estimated at 2000 mm/yr in the coastal areas and 1000 mm/yr or less in the interior mountains (Calvesbert 1970). February, March, and April are drier than the other months.

Mangrove, dry, deciduous, rain, lower montane, upper montane, palm, and elfin forest are terms that indicate the variability of the island's vegetation types. Several authors have described them according to their preferred classification schemes (Gleason and Cook 1927, Beard 1944, Stehlé 1945, Dansereau 1966, Ewel and Whitmore 1973). The last classification recognized six Life Zones (Holdridge 1947, 1967) of which the Subtropical Dry, Subtropical Moist, and Subtropical Wet Life Zones comprised 98.6 percent of the island's land area (fig. 1).

Nine research plots were selected within three Life Zones (fig. 1): one in Subtropical Dry at Guanica on azonal limestone soil; six in Subtropical Moist, two at Cambalache on azonal limestone soil with different exposures, three at Piñones mangrove, and one on zonal soil at St. Just; and two in the Lower Montane Wet Colorado association, one at Toro Negro on zonal soils, and one at Maricao on serpentine. Mean monthly and mean annual rainfalls and temperatures for each plot are provided in figure 2.

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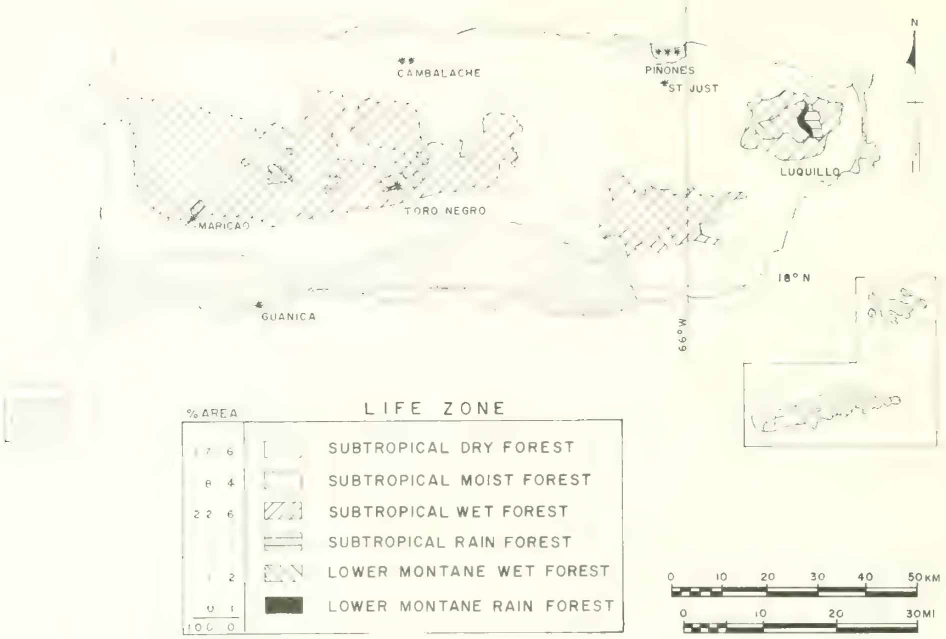

Figure 1.—*Ecological Life Zones of Puerto Rico and location of study sites indicated by asterisk (adapted from Ewel and Whitmore, 1973).*

METHODS

On each plot, all trees were measured with a steel tape at diameter at breast height and permanently marked with sequentially numbered tags at 15 cm below diameter at breast height to avert errors due to swelling. Crown classes were also recorded. In some instances, thinnings or clearcuts were made. Periodically thereafter, the plots were revisited, and the surviving trees measured again. Simultaneously, mortality was observed, and during the final measurement, both ingrowth and mortality were tallied.

Details about plot sizes, number of stems, soil types (U.S. Dep. Agric. 1972), and silvicultural treatments are compiled in table 1. The Life Zone system is used as a framework for analysis because results are often applicable in corresponding Life Zones elsewhere.

Statistical testing of PAI's by crown classes was done with Tukey's Omega Procedure (Steel and Torrie 1960). Statistical testing of PAI's among species, however, was considered inappropriate because of possible confounding due to unequal replication, grouping without respect to crown class, and differential effects of previous silvicultural treatments.

The Shannon-Weiner Index, which is influenced by both the variety and equitability of the species sampled (Krebs 1972), was used to determine species diversity. All species names were derived from *Common Trees of Puerto Rico and the Virgin Islands* (Little and Wadsworth 1964, Little and others 1974).

RESULTS

Subtropical Dry Life Zone

Subtropical Dry Forest on limestone occupies 210 km^2 or 13 percent of the Life Zone, which in turn occupies 1650 km^2 or 18 percent of Puerto Rico.

In 1944, 66 stems of *Bucida buceras* were measured in secondary forest; by 1975, only 34 stems remained. Mortality was highest in the small diameter classes, and in the suppressed and intermediate crown classes. Since the plot was dimensionless, ingrowth was impossible to determine.

The PAI for the 34 surviving stems is only 0.06 cm/yr, with dominants averaging 0.11 cm/yr, codominants 0.08, intermediates 0.04, and suppressed stems 0.02 cm/yr (table 2). Previous measurements of PAI on the same plot showed that the "thriftiest and most vigorous" trees averaged only 0.13 cm/yr during the first 17 years of measurement (Briscoe 1962).

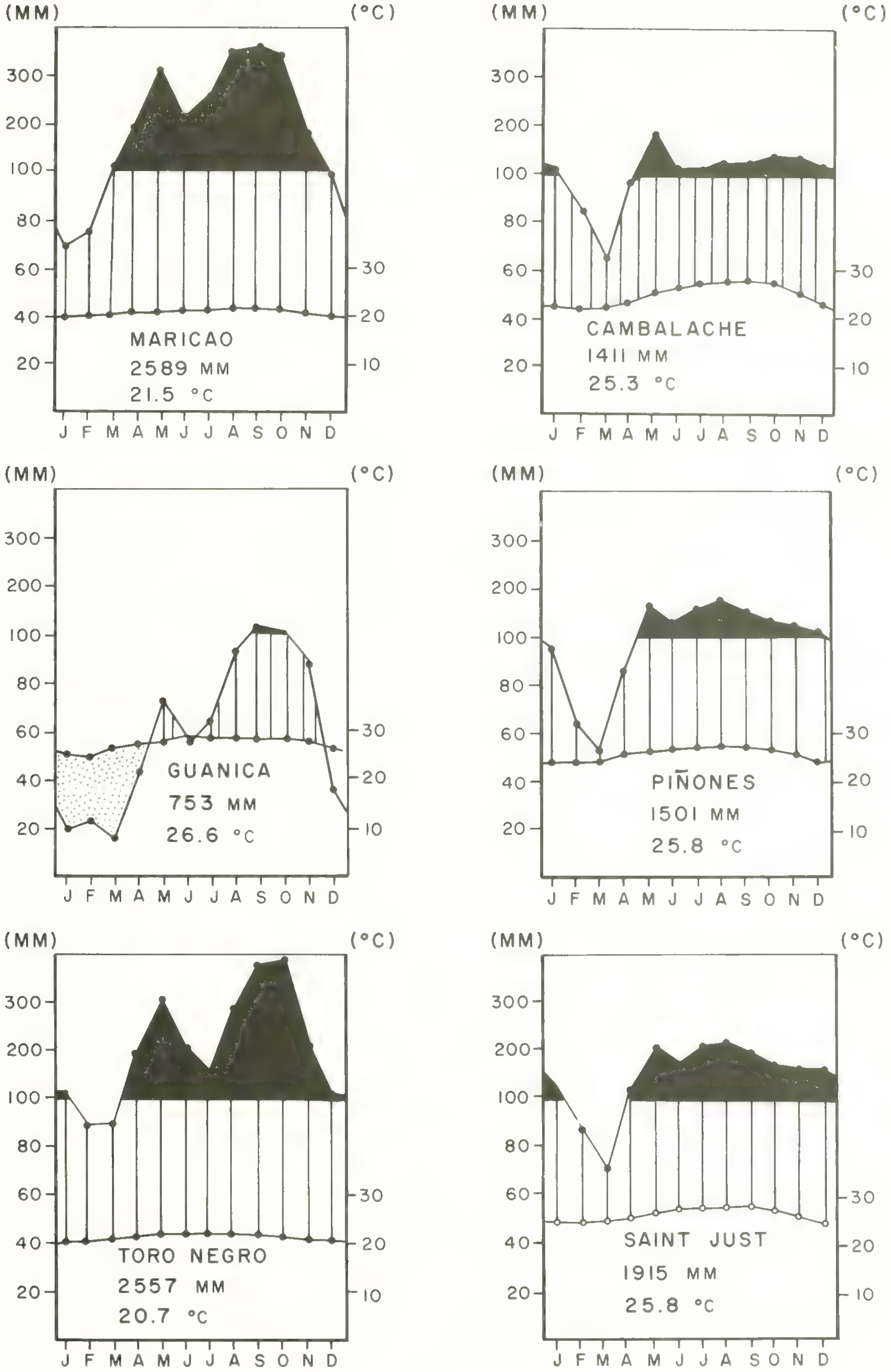

Figure 2.—*Climatic diagrams for six plots in natural forests of Puerto Rico.*

Table 1.— *Selected sites for comparative ecosystem growth study in Puerto Rico*

Holdridge Life Zone (association)	Name of public forest and plots	Number of trees	Plot size in ha (m X m)	Plot Data: Seral stage; soils; elevation; silviculture
Subtropical Dry (Limestone)	Guánica	65	None	Secondary; shallow dry limestone; 150 m; none
Subtropical Moist (Rain forest)	St. Just	1018	0.40 (40 X 100)	Early secondary; shallow, humid volcanic; 60 m; selective thinning before study
Subtropical Moist (Limestone)	Cambalache 1. slope 2. ridge	 402 463	0.10 (20 X 50)	Secondary; lower slopes and ridges of "pepino hills," wet limestone soils; 30 m and 60 m; abandoned agricultural land in mid 1930s
Subtropical Moist (Mangrove)	Piñones 1. Plot A 2. Plot C 3. Plot E	 3789 4098 3317	0.10 (31.6 X 31.6)	Mangrove reproduction; deep organic (mangrove) soils; sea level; plot A and plot C basal area reduced by 50 percent in 1937-38 and again in 1949; Plot A thinned to basal area of 20 m²/ha in 1951, and Plot C to 14 m²/ha; Plot E kept as control
Lower Montane Wet (Colorado)	Toro Negro	245	0.10 (20 X 50)	Late secondary colorado transition; deep, red, acid clay; 930 m; selective thinning in 1947 and 1957
Lower Montane Wet (Colorado)	Maricao	228	0.10 (20 X 50)	Climax; deep, red, acid clay, 670 m; selective thinning in 1951

Table 2.— *Periodic annual diameter increment (PAI) by crown class for* Bucida buceras *from 1944 through 1975 in Guánica Forest (Subtropical Dry Forest) on all trees that survived the entire period*

			1944-1975 statistics[1]			D.b.h. range
Crown Class	1944-54	1954-75	Mean	CV	Stems	1944
		cm/yr		(%)	(No.)	(cm)
Dominant	0.20	0.06	0.11	24	4	8-11
Codominant	0.15	0.04	0.08	30	15	6-10
Intermediate	0.08	0.02	0.04	63	13	4- 9
Suppressed	0.04	0.02	0.02	94	2	5
Total	0.12	0.04	0.06	53	34	4-11

[1] CV = Coefficient of variation.

Subtropical Moist Life Zone

Subtropical Moist Forest occupies 5400 km² or 58 percent of the island.

St. Just. The St. Just forest is an early secondary stand that was selectively thinned before the first measurement. During 2 years of observation, the number of stems decreased from 2460/ha to 1845/ha, and basal area decreased from 12.2 m²/ha to 10.3 m²/ha (table 3). In both years, 10 species accounted for 90 percent of the stems and basal area. Ingrowth and mortality did not appreciably change species composition.

The PAI for all 685 stems during the brief 2-year period of measurement was 0.47 cm/yr, and ranged from a low of 0.15 cm/yr to a high of 0.91 cm/yr for *Buchenavia capitata*, a fast growing species (table 3). The codominant crown class averaged 0.66 cm/yr, followed by intermediates at 0.56, dominants at 0.48, and suppressed stems at 0.40 cm/yr.

The Cambalache Forest. The Cambalache stand is secondary forest on limestone, which occupies 800 km² or 14 percent of the Subtropical Moist Life Zone. Measurements spanned 26 years.

1. The Lower Slope Forest — In 1950, the 10 most common species accounted for nearly 90 percent of the stems and basal area, and by 1976, about 80 percent of each (table 4). During the same period, stems decreased by nearly half while the basal area increased only slightly.

Table 3.— *Ranking of species by density and basal area (BA) dominance in St. Just Forest (Subtropical Moist Forest) from 1952 to 1954*

Species	1952		1954		Ingrowth[1] 1952-54		Mortality by d.b.h. class, 1952-54[1]				1952-54 statistics[2]			D.b.h. range
	Stems (No. ha)	BA (m² ha)	Stems (No. ha)	BA (m² ha)	Stems (No. ha)	BA (m² ha)	5	10	20	Total	Mean (cm yr)	CV (%)	Stems (No.)	1952 (cm)
							----	-------No. ha--	-	--------				
Inga laurina	765	3.70	654	3.91	42	0.07	62	83	8	153	0.63	51	242	4-16
Ocotea leucoxylon	355	1.80	213	0.96	13	0.02	58	84	13	155	.38	80	80	4-19
Nectandra coriacea	245	1.30	176	0.74	13	0.02	41	23	18	82	.20	105	64	4-22
Byrsonima coriacea	205	1.40	148	1.01	2	0.00	17	27	15	59	.35	76	56	4-20
Tetragastris balsamifera	198	0.57	172	0.76	28	0.04	43	11	—	54	.58	42	66	4-20
Casearia arborea	125	0.30	64	0.18	11	0.03	51	21	—	72	.40	82	23	4-10
Miconia prasina	90	0.19	48	0.11	7	0.05	46	3	—	49	.20	85	16	4-10
Manilkara bidentata	85	0.27	80	0.35	—	—	5	—	—	5	.58	35	31	4-13
Hymenaea courbaril	82	1.14	81	1.28	7	0.02	5	3	—	8	.53	78	29	4-45
Casearia guianensis	48	0.09	42	0.01	2	0.00	8		—	8	.25	73	15	4- 8
Chrysophyllum argenteum	45	0.12	29	0.10	2	0.00	16	2	—	18	.40	52	11	4-12
Andira inermis	39	0.12	35	0.14	3	0.01	7		—	7	.28	99	13	4-12
Symplocos martinicensis	38	0.29	20	0.15	—	—	2	11	5	18	.28	96	8	4-12
Zanthoxylum martinicense	22	0.15	12	0.05	—	—	3	5	2	10	.15	77	4	4-16
Buchenavia capitata	18	0.24	15	0.27	—	—		3	—	3	.90	38	6	8-22
Pouteria multiflora	15	0.10	13	0.11	—	—	2		—	2	.38	62	5	4-17
Tabebuia heterophylla	13	0.05	8	0.03	—	—	2	3	—	5	.25	100	3	5- 8
Citharexylum fruticosum	12	0.06	5	0.01	—	—	2	5	—	7	.12	0	2	4- 7
Ficus citrifolia	10	0.08	5	0.01	—	—	—	3	2	5	.12	0	2	4- 5
10 remaining species	49	0.24	26	0.14	2	—	12	11	2	25	.40	72	9	4-18
Total	2459	12.21	1846	10.32	132	0.26	382	298	65	745	0.47	69	685	4-45

[1] *Ingrowth* refers to stems present in final survey but absent in initial survey; *mortality*, stems recorded initially but absent in the final survey. Mortality d.b.h. classes increase geometrically from the 5 cm through 20 cm class: 5 cm (4.1-6.5), 10 cm (6.6-14.1), 20 cm (14.2-26.8). Stems which entered the lowest d.b.h. class (i.e. 4.1 cm) after the initial survey, but died before the final survey, were not tallied.

[2] CV = coefficient of variation.

Table 4.— *Ranking of species by density and basal area (BA) dominance in the Cambalache Slope Forest (Subtropical Moist Forest) from 1950 to 1976*[1]

Species	1950		1976		Ingrowth 1950-76		Mortality by d.b.h. class, 1950-76			
	Stems (No./ha)	BA (m^2/ha)	Stems (No./ha)	BA (m^2 ha)	Stems (No./ha)	BA (m^2/ha)	5	10	20	Total
							------------No. ha--------------			
Tetrazygia elaeagnoides	760	3.64	20	0.12		—	240	490	10	740
Sabinea florida	620	1.43	490	3.16	120	0.23	140	110	—	250
Ardisia obovata	580	1.94	40	0.10	30	0.07	250	320	—	570
Phyllanthus nobilis	430	1.30	300	2.06	110	0.46	140	100	—	240
Thouinia striata	280	0.63	270	2.28	50	0.22	50	10	—	60
Coccoloba diversifolia	200	0.56	100	0.39	30	0.05	100	30	—	130
Guettarda scabra	190	0.40	190	0.58	50	0.13	40	10	—	50
Andira inermis	160	0.49	110	0.56	—	—	10	40	—	50
Bursera simaruba	140	0.47	30	0.29	—	—	90	20	—	110
Dipholis salicifolia	130	0.76	100	1.65	—	—	—	30	—	30
Eugenia rhombea	60	0.14	30	0.08	30	0.07	30	30	—	60
Terebraria resinosa	40	0.15	80	1.06	50	0.24	—	10	—	10
Cupania americana	40	0.08	40	0.25	20	0.03	20	—	—	20
Plumeria alba	40	0.07	10	0.05	—	—	30	—	—	30
Montezuma speciosissima	30	0.13	10	0.13	—	—	—	20	—	20
Citharexylum fruticosum	30	0.12	10	0.06	—	—	10	10	—	20
Cordia nitida	30	0.06	20	0.08	—	—	—	10	—	10
Eupatorium portoricense	30	0.06	—	—	—	—	30	—	—	30
Clusia rosea	20	0.42	10	0.02	—	—	—	—	10	10
Maytenus elliptica	20	0.12	20	0.24	10	0.02	—	10	—	10
Xylosma buxifolium	20	0.01	30	0.13	10	0.02	—	—	—	—
Picramnia pentandra	20	0.04	20	0.18	—	—	—	—	—	—
Allophyllus racemosus	20	0.03	160	0.34	140	0.28	—	—	—	—
Comocladia glabra	20	0.03	20	0.04	20	0.04	20	—	—	20
Exothea paniculata	20	0.03	10	0.02	—	—	10	—	—	10
Dendropanax arboreus	20	0.03	40	0.18	20	0.03	—	—	—	—
11 remaining species	70	0.17	120	0.78	120	0.37	60	10	—	70
Total	1020	13.34	2280	14.83	810	2.26	1270	1260	20	2550

[1] *Ingrowth* refers to stems present in final survey but absent in initial survey; *mortality*, stems recorded initially but absent in the final survey. Mortality d.b.h. classes increase geometrically from the 5 cm through 20 cm class: 5 cm (4.1-6.5), 10 cm (6.6-14.1), 20 cm (14.2-26.8). Stems which entered the lowest d.b.h. class (i.e. 4.1 cm) after the initial survey, but died before the final survey, were not tallied.

Ingrowth and mortality resulted in changes in the dominance ranking: *Tetrazygia elaeagnoides*, *Ardisia obovata*, and *Bursera simaruba*, all secondary species, nearly disappeared from the stand. *Sabinea florida*, *Phyllanthus nobilis*, both present in the original stand, regenerated well.

The PAI for all stems that survived the short term from 1950 to 1956 was 0.16 cm/yr. Dominants grew fastest at 0.26 cm/yr followed by codominants at 0.22, intermediates at 0.14, and suppressed stems at 0.08 cm/yr. The PAI for the 150 stems that survived the entire period of measurement was 0.14 cm/yr, and ranged from 0.02 to 0.39 cm/yr (table 5).

2. The Ridge Forest — From 1950 to 1976, the number of stems increased by 10 percent and the basal area by over 50 percent (table 6). In both years, the 10 most common species accounted for over 95 percent of the stems and basal area.

Ingrowth and mortality, however, changed the dominance ranking: *Ardisia obovata*, a previously abundant secondary species, disappeared entirely from the stand, while *Coccoloba diversifolia*, *Dipholis salicifolia*, *Terebraria resinosa*, *Eugenia rhombea*, *Sabinea florida*, and *Guettarda scabra*, major constituents of the wet limestone forest type, and all present in the original stand, regenerated well. *Bursera simaruba*, *Andira inermis*, and *Tabebuia heterophylla*, generally recognized as secondary species, regenerated within the stand.

The PAI for all stems that survived the 1950-56 period was 0.09 cm/yr, with dominants growing the fastest at 0.17 cm/yr followed by codominants at 0.11, intermediates at 0.08, and suppressed stems at 0.03 cm/yr. The PAI for the 237 trees that survived the entire period of

Table 5.— *Periodic annual diameter increment (PAI) by species from 1950 to 1976 in Cambalache Slope Forest (Subtropical Moist Forest) on all trees that survived the entire period*

Species	PAI			1950-76 statistics[1]			D.b.h. range
	1950-56	1956-67	1967-75	Mean	CV	Stems	1950
	----------cm/yr----------				(%)	(No.)	(cm)
Tetrazygia elaeagnoides	0.20	0.16	0.02	0.12	40	2	7-14
Sabinea florida	.18	.14	.09	.13	55	37	4-18
Ardisia obovata	.08	.12	.08	.09	—	1	6
Phyllanthus nobilis	.19	.12	.14	.14	62	19	4-17
Thouinia striata	.22	.19	.16	.19	57	22	5-18
Coccoloba diversifolia	.05	.05	.06	.06	108	7	4-11
Guettarda scabra	.05	.08	.02	.05	78	14	4- 8
Andira inermis	.14	.05	.04	.07	75	11	4-12
Bursera simaruba	.00	.12	.15	.09	50	3	9-11
Dipholis salicifolia	.31	.17	.11	.19	58	10	8-20
Terebraria resinosa	.24	.47	.40	.39	79	3	5-24
Cupania americana	.29	.22	.19	.23	69	2	8-14
Plumeria alba	.13	.15	.05	.12	—	1	8
Montezuma speciosissima	.51	.05	.05	.14	—	1	12
Citharexylum fruticosum	.15	.00	.00	.04	—	1	8
Cordia nitida	.10	.10	.00	.07	21	2	6- 7
Clusia rosea	.05	.00	.02	.02	—	1	4
Maytenus elliptica	.83	.00	.00	.22	—	1	16
Xylosma buxifolium	.11	.11	.11	.11	69	2	4- 9
Picramnia pentandra	.25	.23	.14	.20	52	2	8
Allophyllus racemosus	.08	.06	.02	.05	30	2	6
Exothea paniculata	.05	.02	.02	.03	—	1	5
Dendropanax arboreus	.22	.19	.09	.16	9	2	9
Ilex nitida	.12	.33	.20	.24	—	1	10
Phylanthus nobilis	.36	.25	.18	.25	—	1	12
Zanthoxylum martinicense	.28	.20	.12	.20	—	1	10
Total	.18	.13	.10	.14	76	150	4-24

[1]CV = coefficient of variation.

Table 6.— *Ranking of species by density and basal area (BA) dominance in Cambalache Ridge Forest (Subtropical Moist Forest) from 1950 to 1976*[1]

Species	1950		1976		Ingrowth 1950-76		Mortality by d.b.h. class, 1950-76			
	Stems (No./ha)	BA (m^2/ha)	Stems (No./ha)	BA (m^2/ha)	Stems (No./ha)	BA (m^2/ha)	5	10	20	Total
							------------No./ha			--------
Coccoloba diversifolia	1040	4.12	1580	7.27	910	2.49	100	260	10	370
Ardisia obovata	950	2.56	—	—	—	—	650	300	—	950
Dipholis salicifolia	710	2.50	810	4.94	230	0.91	90	40	—	130
Terebraria resinosa	680	2.02	810	3.93	250	0.68	70	50	—	120
Eugenia rhombea	380	0.65	970	2.34	740	1.53	130	20	—	150
Bursera simaruba	190	0.56	140	0.79	60	0.15	70	40	—	110
Sabinea florida	160	0.31	220	0.62	140	0.28	50	30	—	80
Andira inermis	110	0.52	60	0.33	20	0.04	50	20	—	70
Tabebuia heterophylla	100	0.41	50	0.31	10	0.02	40	10	10	60
Citharexylum fruticosum	90	0.15	40	0.08	20	0.04	60	10	—	70
Guettarda scabra	80	0.13	190	0.40	130	0.27	20	—	—	20
Tetrazigia elaegnoides	30	0.10	—	—	—	—	10	20	—	30
14 remaining species	50	0.11	250	0.66	220	0.53	—	20	—	20
Total	4570	14.14	5120	21.67	2730	6.94	1340	820	20	2180

[1]*Ingrowth* refers to stems present in final survey but absent in initial survey; *mortality*, stems recorded initially but absent in the final survey. Mortality d.b.h. classes increase geometrically from the 5 cm through 20 cm class: 5 cm (4.1-6.5), 10 cm (6.6-14.1), 20 cm (14.2-26.8). Stems which entered the lowest d.b.h. class (i.e. 4.1 cm) after the initial survey, but died before the final survey, were not tallied.

Table 7.— *Periodic annual diameter increment (PAI) by species from 1950 to 1976 in Cambalache Ridge Forest (Subtropical Moist Forest) on all trees that survived the entire period*

Species	PAI			1950-76 statistics[1]			D.b.h. range
	1950-56	1956-67	1967-75	Mean	CV	Stems	1950
	cm/yr				(%)	(No.)	(cm)
Coccoloba diversifolia	0.16	0.09	0.07	0.10	72	67	4-13
Dipholis salicifolia	.11	.11	.07	.10	74	58	4-14
Terebraria resinosa	.09	.09	.06	.08	71	56	4-12
Eugenia rhombea	.06	.09	.05	.07	45	23	4- 6
Bursera simaruba	.07	.14	.12	.12	69	8	4-10
Sabinea florida	.13	.09	.07	.09	46	8	4- 6
Andira inermis	.02	.01	.00	.01	148	4	5-15
Tabebuia heterophylla	.08	.14	.14	.13	84	4	5- 8
Citharexylum fruticosum	.00	.05	.02	.03	52	2	4- 5
Guettarda scabra	.05	.05	.00	.03	100	6	4- 5
Myrcia leptoclada	.13	.15	.10	.12	—	1	6
Picramnia pentandra	.08	.20	.18	.17	–	1	5
Adelia ricinella	.05	.00	.00	.01	—	1	5
Total	.11	.10	.07	.09	74	237	4-15

[1]CV = the coefficient of variation.

Table 8.— *Rank of species by density and basal area (BA) dominance for all trees from 1938 through 1975 on plots A, C, and E in Piñones Forest*

Plot	Species	1938		1945		1949[1]		1951[1]		1955		1975	
		Stems (No./ha)	BA (m²/ha)	Stems (No./ha)	BA (m²/ha)	Stems (No./ha)	BA (m²/ha)	Stems (No./ha)	BA (m²/ha)	Stems (No./ha)	BA (m²/ha)	Stems (No./ha)	BA (m²/ha)
A	*Laguncularia racemosa*	—	—	26458	18.55	23125	29.73	72	0.61	445	3.67	1285	17.12
	Avicennia nitida	—	—	1300	2.43	1198	4.18	322	2.80	438	5.13	395	6.76
	Total	38920	19.72	27758	20.98	24322	33.91	394	3.41	882	8.80	1680	23.88
C	*Laguncularia racemosa*	—	—	39450	20.13	26460	28.79	52	0.38	585	3.21	1448	22.01
	Avicennia nitida	—	—	1720	3.42	958	4.91	292	2.96	320	4.20	322	6.68
	Total	42096	15.15	40720	23.55	27418	33.70	344	3.34	905	7.41	1770	28.69
E	*Laguncularia racemosa*	—	—	31615	26.38	22178	30.07	178	1.32	458	3.85	1235	18.04
	Avicennia nitida	—	—	698	2.73	435	3.88	395	4.65	405	6.57	260	5.83
	Total	34092	18.78	32313	29.11	22613	33.95	573	5.97	863	10.42	1495	23.87

[1]The apparent discrepancy between the 1949 and 1951 entries is due to a change in sampling procedure. In 1949, all stems were measured; in 1951, only stems ⩾ 9.1 cm.

measurement was also 0.09 cm/yr, and ranged from 0.01 to 0.17 cm/yr (table 7).

The PAI for all surviving stems on the slope exceeded that on the ridge. Also, the PAI's of each crown class were higher on the slope than the ridge, and in general, individual species grew faster on the slope. The exceptions were *Coccoloba diversifolia* and *Bursera simaruba* (tables 5 and 7).

Previously reported PAI's also varied by site. Two hundred codominant trees of several species, selected at random, on both lower slope and summit, averaged 0.30 and 0.15 cm/yr respectively, (U.S. Dep. Agric. For. Serv. 1954).

Piñones Mangrove Forest. Originally, mangroves covered about 27,000 ha in the Subtropical Moist and Subtropical Dry Life Zones of which slightly over 3000 ha remain today.

In 1937, three plots in the Piñones Forest were cleared (table 1). Regeneration after clearing yielded about 40,000 stems/ha (table 8). In 1945 and 1949, less than 5 percent of the stems were *Avicennia* although the basal area ranged from 10 to 15 percent of the stand. In 1951, after a change in sampling procedure (table 8), 70 percent or more of the total stems ⩾ 9.1 cm, as well as 80 percent or more of the basal area, belonged to *Avicennia*. By 1975, *Laguncularia* once again dominated the stand in stem numbers and basal area, although *Avicennia* was well represented among the larger stems.

The PAI of *Avicennia* exceeded that of *Laguncularia* from 1938 to 1955 (table 9), but this trend was reversed from 1955 through 1975. An overall estimate of PAI for both species on all three plots over the 37-year duration of the study is 0.45 cm/yr.

Previously reported mean annual d.b.h. increments (MAI) at Piñones are high. In a sapling stand, dominants averaged 0.82 cm/yr, codominants 0.49, intermediates 0.32, and suppressed stems 0.16 cm/yr during 4 years; in a pole stand these averages were 0.46, 0.40, 0.24, and 0.17, respectively, during 3 years (Wadsworth 1959).

Table 9.— *Mean annual diameter increment by species from 1938 through 1975 in Piñones Forest on trees that survived the entire period*

Plot	Species	Mean annual diameter increment				Trees[1] (No.)
		1938 -51	1951 -55	1955 -65	1938 -75	
		cm/yr				
A	*Laguncularia racemosa*	0.77	0.42	0.30	0.48	6
	Avicennia nitida	0.79	0.63	0.13	0.42	14
	Subtotal	0.78	0.57	0.18	0.44	20
C	*Laguncularia racemosa*	0.74	0.62	0.38	0.54	5
	Avicennia nitida	0.85	0.69	0.14	0.46	17
	Subtotal	0.82	0.67	0.19	0.48	22
E	*Laguncularia racemosa*	0.71	0.36	0.33	0.47	8
	Avicennia nitida	0.97	0.55	0.20	0.51	4
	Subtotal	0.80	0.42	0.28	0.48	12
	Total	0.80	0.58	0.21	0.46	54

[1] More trees survived, but only those trees that could be positively identified by tags were used.

Lower Montane Wet Life Zone

This Life Zone, scattered in the summits of the Cordillera Central and Luquillo Mountains, occupies 110 km² or about 1 percent of the island.

Toro Negro. The late secondary colorado forest at Toro Negro was harvested for fence posts in 1947, and had all stems $\leqslant$ 12 cm removed in 1957.

During the 24-year period of measurement, the number of stems decreased by 30 percent while basal area increased only slightly (tabie 10). In 1951 and 1975, over 90 percent of the stems and over 85 percent of the basal area belonged to only 10 species. During that same period, ingrowth, mortality, and selective thinning resulted in compositional changes: *Solanum rugosum*, *Cecropia peltata*, *Policourea riparia*, and *Miconia prasina*, secondary species that invaded the plot after thinning, largely disappeared; *Myrcia splendens*, *Byrsonima wadsworthii*, *Guatteria blanii*, and *Ocotea leucoxylon*, all climax species common in the understory, were probably removed in the 1957 thinning of small stems; and, *Micropholis garciniaefolia*, *Dacryodes excelsa*, both climax overstory species, and *Casearia arborea*, a common understory tree in both secondary and climax forests, reproduced well within the stand.

The PAI for all stems that survived the 1951-56 interval was 0.24 cm/yr with codominants growing the fastest at 0.32 cm/yr followed by the intermediates at 0.29, the dominants at 0.25, and the suppressed stems at 0.11 cm/yr. The PAI for the 109 stems that survived the entire period of measurement was 0.15 cm/yr, and ranged from 0.05 to 0.50 cm/yr (table 11).

Maricao Serpentine Forest. Serpentine soils occupy 65 km² on the island, a small part of which is in the Lower Montane Wet Life Zone. In 1951, suppressed stems were removed on the Maricao plot to provide growing space for remaining trees.

During the 24-year period of measurement, the number of stems decreased by about 10 percent while the basal area increased by over 35 percent (table 12). In 1951 and 1975, the 10 most common species accounted for over 70 percent of the stems and 75 percent of the basal area. Ingrowth, mortality, and the effects of selective thinning had an effect on composition: *Drypetes alba*, a persistent understory climax species, reproduced well. *Pseudolmedia spuria*, *Eugenia jambos*, *Cecropia peltata*, *Rapanea ferruginea* and *Casearia sylvestris*, all secondary species, as well as nine additional species, regenerated within the stand in limited numbers.

The PAI for all stems that survived the 1951-56 interval was 0.10 cm/yr, with only slight differences among crown classes. Codominants grew the fastest at 0.15 cm/yr followed by dominants at 0.11, suppressed at 0.09, and intermediate stems at 0.08 cm/yr.

The PAI for those stems that survived the entire period of measurement was 0.12 cm/yr and ranged from 0.03 cm/yr for *Ocotea leucoxylon* to 0.58 cm/yr for *Ficus citrifolia*, the strangler fig (table 13).

Table 10.—*Ranking of species by density and basal area (BA) dominance in Toro Negro Forest from 1951 to 1976*[1]

Species	1951		1975		Ingrowth 1951-75		Mortality by d.b.h. class, 1951-75				
	Stems (No./ha)	BA (m^2/ha)	Stems (No./ha)	BA (m^2/ha)	Stems (No./ha)	BA (m^2/ha)	5	10	20	40	Total
							No./ha				
Micropholis garciniaefolia	1050	6.32	1010	10.41	250	0.48	160	120	10	—	290
Solanum rugosum	390	1.06	10	0.15	10	0.15	170	220	—	—	390
Cecropia peltata	260	2.25	20	0.28	—	—	40	110	90	—	240
Eugenia stahlii	170	1.26	90	1.44	10	0.01	50	40	—	—	90
Dacryodes excelsa	120	5.32	110	5.99	—	—	10	—	—	—	10
Myrcia splendens	100	0.50	—	—	—	—	30	70	—	—	100
Matayba dominguensis	40	2.14	30	1.63	—	—	—	—	—	10	10
Rapanea ferruginea	40	0.11	20	0.49	—	—	—	20	—	—	20
Calycogonium squamulosum	30	0.89	—	—	—	—	10	20	—	—	30
Byrsonima wadsworthii	30	0.56	—	—	—	—	—	20	10	—	30
Guatteria blanii	30	0.31	—	—	—	—	—	30	—	—	30
Casearia arborea	30	0.05	180	0.68	170	0.58	—	20	—	—	20
Didymopanax mortotoni	20	0.26	20	0.46	10	0.20	—	—	10	—	10
Ocotea leucoxylon	20	0.07	—	—	—	—	10	10	—	—	20
Cordia sulcata	20	0.05	10	0.10	—	—	—	10	—	—	10
Palicourea riparia	20	0.03	—	—	—	—	20	—	—	—	20
Miconia prasina	20	0.03	50	0.33	50	0.33	10	10	—	—	20
Cedrela odorata	20	0.03	10	0.13	—	—	10	—	—	—	10
Buchenavia capitata	10	2.06	10	2.47	—	—	—	—	—	—	—
8 remaining species	30	0.10	120	1.01	100	0.57	10	—	—	—	10
Total	2450	23.40	1690	25.57	600	2.32	530	700	120	10	1360

Ingrowth refers to stems present in final survey but absent in initial survey; *mortality*, stems recorded initially but absent in the final survey. Mortality d.b.h. classes increase geometrically from the 5 cm through 40 cm class: 5 cm (4.1-6.5), 10 cm (6.6-14.1), 20 cm (14.2-26.8), 40 cm (26.9-54.6). Stems which entered the lowest d.b.h. class (i.e. 4.1 cm) after the initial survey, but died before the final survey, were not tallied.

Table 11.— *Periodic annual diameter increment (PAI) by species from 1951 through 1976 in Toro Negro Forest on all trees that survived the entire period*

Species	PAI				1951-76 statistics[1]			D.b.h. range
	1951-56	1956-62	1962-67	1967-75	Mean	CV (%)	Stems (No.)	1951 (cm)
	cm/yr							
Micropholis garciniaefolia	0.19	0.18	0.11	0.08	0.14	51	76	5-23
Cecropia peltata	.30	.24	.04	.14	.19	48	2	5-10
Eugenia stahlii	.24	.17	.02	.11	.12	79	8	5-23
Dacryodes excelsa	.12	.08	.10	.09	.09	126	11	10-48
Matayba dominguensis	.32	.28	.22	.16	.25	76	3	10-36
Rapanea ferruginea	.82	.57	.28	.26	.50	18	2	5
Casearia arborea	.55	.40	.22	.04	.27	—	1	5
Didymopanax morototoni	.80	.57	.31	.38	.50	—	1	5
Cordia sulcata	.70	.31	.04	.00	.23	—	1	5
Cedrela odorata	.65	.44	.09	.34	.37	—	1	5
Buchenavia capitata	.10	.18	.31	.20	.20	—	1	51
Guarea ramiflora	.00	.40	.00	.04	.11	—	1	8
Ocotea moschata	.05	.09	.04	.04	.05	—	1	8
Total	.21	.19	.11	.09	.15	71	109	5-51

[1]CV = coefficient of variation.

Table 12.—*Ranking of species by density and basal area (BA) dominance in Maricao Forest from 1951 to 1975*

Species	1951		1975		Ingrowth 1951-75		Mortality by d.b.h. class, 1951-75		
	Stems (No./ha)	BA (m² ha)	Stems (No./ha)	BA (m² ha)	Stems (No./ha)	BA (m²/ha)	5	10	Total
							No. ha		
Micropholis chrysophylloides	280	2.72	200	3.00	30	0.05	40	70	110
Terebraria resinosa	230	1.62	140	1.78	10	0.03	30	70	100
Linociera dominguensis	230	1.31	110	1.50	—	—	30	90	120
Homalium racemosum	190	0.70	170	1.29	30	0.06	20	30	50
Tabebuia schumanniana	180	0.74	130	0.71	10	0.02	20	40	60
Eugenia stahlii	130	1.10	100	1.40	—	—	10	20	30
Myrcia splendens	120	0.68	80	0.93	20	0.08	40	20	60
Matayba dominguensis	120	0.47	90	0.76	10	0.03	20	20	40
Cordia borinquensis	50	0.15	20	0.11	—	—	20	10	30
Plumeria alba	40	0.16	40	0.35	—	—	—	—	—
Guettarda ovalifolia	40	0.14	40	0.08	40	0.08	30	10	40
Myrtaceae	30	0.17	30	0.39	—	—	—	—	—
Guatteria blainii	30	0.13	10	0.04	—	—	20	—	20
Ocotea leucoxylon	30	0.07	50	0.12	20	0.03		—	—
Myrcia deflexa	30	0.06	40	0.18	20	0.03	10	—	10
Micropholis garciniaefolia	20	0.27	20	0.38	—	—	—	—	
Coccoloba swartzii	20	0.12	20	0.27	—	-		—	
Lauraceae	20	0.05	10	0.02	—	—	10	—	10
Drypetes glauca	20	0.04	-		—	—	20	—	20
Ficus citrifolia	10	0.34	10	0.95	—	—	—	—	—
Drypetes alba	10	0.06	130	0.34	130	0.34	—	10	10
24 remaining species	120	0.39	280	1.06	230	0.59	60	10	70
Total	1950	11.49	1720	15.66	550	1.34	380	400	780

[1] *Ingrowth* refers to stems present in final survey but absent in initial survey; *mortality*, stems recorded initially but absent in the final survey. Mortality d.b.h. classes increase geometrically from the 5 cm to 10 cm class: 5 cm (4.1-6.5), 10 cm (6.6-14.1). Stems which entered the lowest d.b.h. class (i.e. 4.1 cm) after the initial survey, but died before the final survey, were not tallied.

Both plots in the Lower Montane Wet Forest share species, but Maricao contains some that are also found in the drier coastal forests: *Terebraria resinosa*, *Tabebuia schumanniana*, *Guettarda ovalifolia*, *Ocotea cuneata*, *Coccoloba sintenisii*, *Eugenia monticola*, and *Cassipourea elliptica*.

Species Diversity on Plots

The number of species per plot ranged from a low of two in the Piñones mangrove forest to a high of 39 at the end of the study in the Maricao serpentine forest (table 14). In the mangrove forest, the Shannon-Weiner species diversity index was below 1.0 and in the Maricao serpentine forest, above 4.0; other forests were intermediate in both species numbers and diversity (table 14).

DISCUSSION

Increment

The reported PAI's corroborate previous studies in Puerto Rico and are similar to those of the temperate zone. For example, *Acer saccharum*, *Quercus rubra*, *Pinus strobus*, and *P. taeda*, common species in the United States, average from 0.15 to 0.50 cm/yr (U.S. Dep. Agric. For. Serv. 1965), even though the growing season ranges from under 200 to 300 days/yr. Furthermore, Jordan (1971) suggests that the rate of woody production in intermediate age stands on mesic sites, regardless of latitude, is similar.

The fastest PAI's for all measured stems were found in St. Just and Piñones forests. St. Just is a selectively thinned early secondary stand measured over 2 years. As the stand develops, competition among stems will probably reduce PAI considerably. The Piñones stands are mangrove regeneration plots that were measured after clearing. An earlier study that summarized the development of the stands from 1938 to 1953 found that the control plot grew rapidly with stems equal in form and quality to the crop trees of the thinned plots (U.S. Dep. Agric. For. Serv. 1954). In 1975, plot C had from 5 to 18 percent more stems, and about 20 percent more basal area

Table 13.— *Periodic annual diameter increment (PAI) by species from 1951 through 1975 in Maricao Forest on all trees that survived the entire period*

Species	PAI			1951-75 statistics[1]			D.b.h. range
	1951-56	1956-67	1967-75	Mean	CV	Stems	1951
	----------cm/yr----------				(%)	(No.)	(cm)
Micropholis chrysophylloides	0.09	0.10	0.12	0.11	54	17	5-25
[illegible]	.13	.09	.09	.10	63	13	5-18
Linociera domingensis	.17	.16	.16	.16	56	11	5-12
Homalium racemosum	.12	.12	.20	.15	57	14	5-10
Tabebuia schumanniana	.05	.08	.10	.08	85	12	5-12
Eugenia stahlii	.12	.09	.08	.09	43	10	5-18
Myrcia splendens	.10	.10	.11	.10	45	6	5-18
Matayba domingensis	.12	.13	.12	.12	92	8	5-10
Cordia borinquensis	.08	.06	.02	.05	42	2	5- 8
Plumeria alba	.06	.07	.23	.15	33	4	5-10
Myrtaceae	.16	.18	.17	.17	61	3	8-10
Guatteria blainii	.00	.15	.09	.09	–	1	5
Ocotea leucoxylon	.03	.02	.05	.03	115	3	5
Myrcia deflexa	.38	.20	.15	.22	–	1	5
Micropholis garciniaefolia	.07	.11	.11	.10	23	2	13
Coccoloba swartzii	.10	.08	.11	.10	17	2	12
Lauraceae	.05	.02	.06	.04	–	1	4
Ficus citrifolia	.50	.64	.55	.58	–	1	20
Buchenaria capitata	.43	.39	.31	.38	–	1	8
[illegible]	.24	.24	.25	.24	–	1	8
Guapira fragrans	.05	.05	.03	.04	–	1	5
Ardisia obovata	.00	.05	.18	.07	–	1	8
Total	.11	.11	.13	.12	75	115	5-25

[1] CV = coefficient of variation.

than either A or E, which are remarkably similar (table 8). The effects of selective thinning have not been fully tested in this experiment.

The Guanica plot has the lowest rate of PAI. Since only one species was measured, generalities about the forest are difficult. It may be hypothesized, however, that since *Bucida* is one of the largest stems in the Guanica Forest, its PAI probably exceeds the average for all species. The remaining plots, Cambalache slope and ridge, Toro Negro, and Maricao, are uniform in size, of nearly equal duration of measurement, and have PAI's intermediate between those of St. Just and Guanica.

Comparisons among stands are difficult because of confounding due to many factors (species, soils, seral stages, age of stems, silviculture, and different durations of measurement), yet certain trends seem apparent. Early secondary forests represented by St. Just and Piñones, are comparatively fast growing. The PAI on surviving stems in secondary forests that have been measured over a long period shows a gradual decline probably due to closing of the stand and/or senescence. On Cambalache slope, for example, suppressed stems increased in relative abundance from 20 to 50 percent, on Cambalache ridge from 10 to 20 percent, and at Maricao from 5 to 15 percent; at Toro Negro, 25 percent of the stems were suppressed throughout the period of measurement.

In the wet limestone hills represented by Cambalache, exposed summits have lower PAI's than the slopes, probably because of moisture stress. With ascent of the mountains, PAI's decrease. Saturated soils and reduced solar radiation have been suggested as causes

Table 14.— *Total numbers of species and Shannon-Weiner diversity indices (H) for several forests in Puerto Rico*

Public forests and plots	No. of Species		H[1]	
	Beginning	End	Beginning	End
St. Just	29	25	3.42	3.28
Cambalache				
1. slope	34	33	3.80	3.96
2. ridge	17	22	3.05	2.91
Piñones	2	2	0.15	0.67
Toro Negro	22	20	2.93	2.38
Mariacao	31	39	4.06	4.32

[1] $H = -\sum_{i=1}^{s} (pi)(\log_e pi)$.

Wadsworth 1952). In the dry limestone forest, lack of moisture again hinders tree growth (Lugo *et al.* 1979).

Crown classes appear useful as indicators of growth potential. On limestone soils, PAI by crown class for all stems, regardless of species exhibits the pattern D > CD > I > S, probably reflecting the competitive advantage of larger stems in an environment where water is limiting. On mesic sites, the pattern CD = D = I > S prevails. This pattern does not corroborate previous work in the Subtropical Wet Forest of Luquillo (Crow and Weaver 1977) where D > CD > I > S was most common. The Luquillo study, however, dealt with thinned "crop trees" by species, whereas this study considered all stems by plot.

Although exceptional rates of growth have been reported for many plantations of exotics in the tropics, PAI's in excess of 1 cm/yr are rare in undisturbed tropical forests (Fernando 1962, Keay 1961, Crow and Weaver 1977). These modest growth rates have been attributed to the energetic costs of plant maintenance necessary for trees to survive in a highly competitive environment (Odum and Jordan 1970, Kira 1969).

Because controls were missing, the selective thinnings practiced in St. Just, Toro Negro, and Maricao do not lead to any firm conclusions about their effect on the residual stands. Nor do the PAI's reported herein reflect the growth potential of the stands under continuous management. First, the thinnings in Toro Negro and Maricao were conducted in stands that were late secondary or climax. Crown growth must be encouraged early in stand development since "big trees are unable to respond to silvicultural treatment much if at all" (Whitmore 1975). Second, as mentioned previously, from 15 to 50 percent of the stems in Cambalache and both montane forests were overtopped. Increment in the suppressed crown class, regardless of environment, is slow in comparison to dominant, codominant, and most intermediate stems.

Species Diversity

In Puerto Rico, four species dominate mangrove soils: *Rhizophora mangle*, largely limited to the seaward or estuarine fringe; *Conorcarpus erecta*, at the landward edge; and *Laguncularia racemosa* and *Avicennia nitida*, in the central portion, or basin (Wadsworth 1959, Lugo and Snedaker 1974). The latter two species probably constitute 95 percent of the stems in the Piñones Forest.

In the Cambalache Forest, species numbers and diversity indices are greater on slopes than on ridges. This reflects the severe stress caused by well-drained limestone soils on the exposed hilltops (table 14). The comparatively low values for St. Just and Toro Negro are probably due to the selective removal of certain species during the improvement cuttings.

In the colorado type, which corresponds to the mature vegetation of the zonal association within the Subtropical Wet Life Zone, 57 species have been identified (Wadsworth 1951). The high number of species and high species diversity index on the Maricao plot (table 14) could reflect the well-drained and well-aerated nature of these serpentine soils (Tschirley *et al.* 1970). The sharing of species between the Cambalache and Maricao forests supports this hypothesis.

Investigations of species diversity within the southern mixed hardwoods and mixed mesophytic forest of the United States yielded indices from 2.0 through 3.4, with most values below 3.0 (Monk 1967). Within the tropics, Jin-Bee (1960) reported that the mangrove forests of the Malay peninsula contained 17 principal species, and that a typical 0.4 ha patch of lowland rain forest would contain about 200 trees of about 100 species. Although direct comparisons are difficult to make, the forests of Puerto Rico apparently are intermediate in diversity between continental temperate and continental tropical forests.

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Presents periodic annual diameter increment for about 2400 stems $\geqslant$ 4.1 cm d.b.h., which were studied for periods ranging from 2 to 30 years. Over 100 tree species and three Life Zones on the island are represented.

Additional keywords: diameter increment, species composition, basal area, ingrowth, mortality, species diversity.

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Soil, Slope, and Rainfall Affect Height and Yield in 15-Year-Old Southern Pine Plantations

EUGENE SHOULDERS AND FRANCES V. WALKER

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SUMMARY

Equations are presented for predicting heights at age 15 of dominant and codominant loblolly, slash, longleaf, and shortleaf pine from characteristics of the planting site. Yields of these species at age 15 can be predicted from height of the dominant stand and from stand density. Tables are included which contain solutions of these equations for many site characteristics and tree densities.

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1979

Soil, Slope, and Rainfall Affect Height and Yield in 15-Year-Old Southern Pine Plantations

EUGENE SHOULDERS AND FRANCES V. WALKER

INTRODUCTION

In Louisiana and Mississippi during 1954–58, scientists of the Southern Forest Experiment Station, with assistance from private and public forestry organizations, planted 113 trials of the four major species of southern pines. Every installation contained loblolly (*Pinus taeda* L.), longleaf (*P. palustris* Mill.), and slash pine (*P. elliottii* Engelm. var. *elliottii*). About half also included shortleaf pine (*P. echinata* Mill.).

For each species, this paper reports relationships between height of the dominant stand at 15 years and selected characteristics of the planting sites. It also reports relationships between number of trees, 15-year heights, and yield at 15 years. The paper contains tables of predicted heights with corresponding volumes by stocking levels for an array of soil textures, amounts of rainfall, and other characteristics of the sites. Relative performance of the four species through age 15 was reported in Shoulders (1976, 1977).

PROCEDURES

Design of the study

Three plots of each of three species (four, when shortleaf pine was included) were planted at each location in a randomized block design. Planting interval was 6 feet within and between rows. West of the Mississippi River, gross plots contained 11 rows of 11 trees; east of the River in Mississippi and the Florida parishes of Louisiana, they contained 12 rows of 12 trees each. Growth and yield data were obtained from the area occupied by the center 49 or 64 planting positions.

Planting sites

The plantings were widely distributed on open sites in the two-State area south of a line formed by extending Louisiana's northern boundary across Mississippi (fig. 1). While some installations were on old fields, most were on cutover forest land. Collectively, the outplantings were representative of important pine sites in the two States (table 1).

Soil profile characteristics were used to classify the sites as wet, intermediate, or dry. Wet-site soils lacked abrupt changes in color or texture within the surface 3 to 4 feet. These soils remain submerged or saturated with water during wet periods, especially in winter. They range in internal drainage from very poor to moderately good. The main distinguishing characteristic of intermediate sites was that the soils had well-defined horizons which differed from each other in both texture and color. These soils are moderately well to well drained. The dry sites had a surface layer, at least 3 feet thick, of coarse sand to sandy loam soil. The soils have good to excessive internal drainage and a very limited capacity for storing readily available moisture.

Planting and replanting

Seedlings used in the test plantings were grown in State, Federal, and industrial nurseries in Louisiana and Mississippi. Healthy, uninjured

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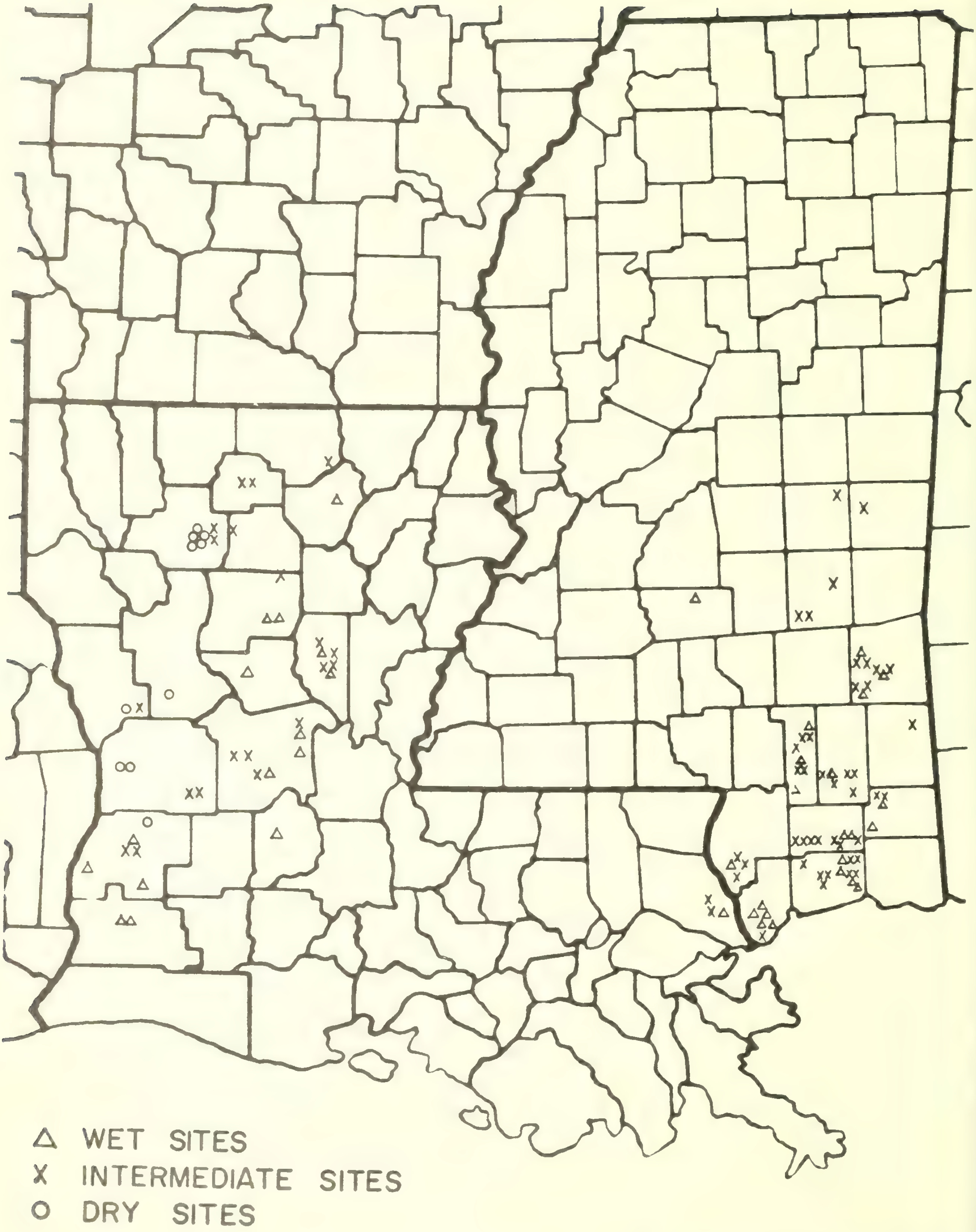

Figure 1.—*Locations of outplantings.*

plants in Wakeley's (1954) morphological grades 1 and 2 were selected for outplanting.

Loblolly pine seedlings planted east of the Mississippi River were from seedlots collected in Mississippi, and those west of the River were from Louisiana seedlots. Slash pine seedlings for more than 80 percent of the plots were produced from seed collected in southern Mississippi or the Florida parishes of Louisiana. Seed for the remaining stock was obtained from a Georgia dealer. Shortleaf seedlings from a Louisiana seed source were used in seven Mississippi installations. Otherwise, longleaf and shortleaf seedlings planted in Mississippi were from seedlots collected in Mississippi, and those planted in Louisiana were from seedlots collected in Louisiana. No genetically improved seed was used.

After 1 year, plots with less than about 80 percent survival were replanted to eliminate as nearly as possible the effect of stocking level on subsequent yields. Two procedures were used. In Mississippi and the Florida parishes of Louisiana, survivors on inadequately stocked plots were destroyed, and plots were completely replanted. A few plots were destroyed and replanted more than once. West of the River in Louisiana, individual dead or missing seedlings were replaced with 1-0 nursery stock or the entire outplanting was destroyed and replanted. Of these procedures, replacement of individuals was the least desirable alternative. Interplanted trees grow slower and contribute much less to stand yields than do survivors of the original planting (Schultz 1965). The amount of interplanting was not sufficient, however, to bias results unduly. Nineteen successful installations were established in 1954, 42 in 1955, 38 in 1956, 12 in 1957, and 2 in 1958.

Measurements and analysis of data

Survival of the initial plantings was inventoried at the end of the first growing season. Subsequent inventories when trees on most plots in an installation were 2 or 3, 10, and 15 years old provided information on tree size, stocking, yield, and numbers of deaths caused by fusiform rust. Installations west of the Mississippi River were also inventoried at 5 years. Interplanted trees were measured but not identified in later inventories.

The age 15 inventory included measurement of diameter at breast height (d.b.h.) of all trees and of total heights and upper stem dimensions of 12 randomly selected trees per plot. Total heights of other randomly selected trees were measured if they were needed to provide a sample of at least 10 dominant and codominant trees on each plot for estimating average height of the dominant stand.

Sample-tree volumes were determined by the height accumulation procedure (Grosenbaugh 1954). Total and merchantable outside bark volumes per acre for individual plots were computed by applying volume-basal area ratios of the 12-tree sample to plot basal areas after the latter were converted to per-acre values (Lohrey and Dell 1969). Total cubic foot volumes included wood and bark in the entire stem of all trees 0.6 inch in d.b.h. and larger; merchantable volumes included trees 4.6 inches in d.b.h. and larger to a 4.0-inch top.

Data were collected on topographic and soil profile characteristics of the sites when plantations were 1 to 8 years old. Soil in each block of each installation was sampled and analyzed for the properties listed in table 1. (Because they lacked abrupt changes in texture and color in the surface 3 to 4 feet, soils of wet and dry sites were sampled at specific depths rather than in specific horizons.) These properties had been identified as the physical soil characteristics most likely to be associated with tree growth (Coile 1952, Zahner 1958).

Latitude and longitude of each installation were scaled from maps. Rainfall information for the weather station nearest to each installation was compiled from U.S. Weather Service reports.

Dominant and codominant tree heights at 15 years were related to characteristics of the planting site and volume was related to height, age, and stocking by regression analyses. Variables were tested for inclusion in these equations by Grosenbaugh's (1967) system for combinatorial screening of multivariate regressions.

To insure reliability of the data included in the analyses, no plot having less than 20 percent of the original planting spaces occupied at the last inventory or with less than three-fourths of the stand in trees of the designated species was used in evaluating height or yield. (Errors in replanting were responsible for trees of the wrong species being present.) Plots seriously damaged by wildfire or hurricanes were also ex-

Table 1.—*Extremes in selected characteristics of the planting sites*

Item	Unit of measure	Loblolly		Slash		Longleaf		Shortleaf	
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Wet sites									
Latitude	Degrees	30.2	32.5	30.2	32.5	30.2	32.5	30.3	32.5
Longitude	Degrees	88.8	93.7	88.8	93.7	88.8	93.7	89.6	93.3
Average annual rainfall	Inches	52	72	52	72	52	72	52	63
Average growing season rainfall	Inches	24	46	24	46	24	46	25	36
Slope	Percent	0	7	0	7	0	7	0	2
Organic matter in A1 horizon[1]	Percent	0.5	11.5	0.5	11.5	0.5	11.5	0.5	2.4
Available water holding capacity on 16–20 inch layer[2]	Percent	2	22	2	22	5	22	5	22
Texture of 6–10 inch layer									
Sand	Percent	7	72	7	72	7	72	17	62
Silt	Percent	19	73	19	73	19	73	30	65
Clay	Percent	5	35	5	35	5	35	6	22
Texture of 16–20 inch layer									
Sand	Percent	8	88	8	88	8	70	16	68
Silt	Percent	9	73	9	73	19	73	19	63
Clay	Percent	3	56	4	56	4	56	10	35
Intermediate sites									
Latitude	Degrees	30.1	32.8	30.1	32.8	30.1	32.8	30.1	32.8
Longitude	Degrees	88.1	93.5	88.1	93.5	88.1	93.5	88.1	93.3
Average annual rainfall	Inches	47	72	47	72	47	72	47	66
Average growing season rainfall	Inches	24	46	24	46	24	46	24	38
Slope	Percent	1	14	1	14	1	14	1	14
Organic matter in A1 horizon	Percent	0.2	5.3	0.2	5.3	0.2	5.3	0.2	5.3
Thickness of A horizon	Inches	2	40	2	30	2	25	2	22
Available water holding capacity of 16–20 inch layer	Percent	<0.5	23	<0.5	23	<0.5	23	<0.5	18
Texture of A2 horizon									
Sand	Percent	16	93	16	93	16	93	16	93
Silt	Percent	2	66	2	66	2	66	2	66
Clay	Percent	4	27	4	27	4	27	4	20
Texture of B2 horizon									
Sand	Percent	5	90	5	90	5	90	5	90
Silt	Percent	2	56	2	56	2	56	2	56
Clay	Percent	6	60	6	60	6	60	6	60
Dry sites									
Latitude	Degrees	30.8	32.3	30.8	32.3	30.8	32.3	31.3	32.3
Longitude	Degrees	93.0	93.4	93.0	93.4	93.0	93.4	93.0	93.4
Average annual rainfall	Inches	46	56	46	56	46	56	50	52
Average growing season rainfall	Inches	24	28	24	28	24	28	25	28
Slope	Percent	2	11	2	11	2	11	2	11
Organic matter in A1 horizon	Percent	0.2	1.2	0.2	1.2	0.2	1.2	0.2	1.2
Available water holding capacity of 16–20 inch layer	Percent	1	9	1	9	1	9	1	5
Available water holding capacity of 36–42 inch layer	Percent	<0.5	10	<0.5	10	<0.5	10	<0.5	6

Table 1. — *Extremes in selected characteristics of the planting sites* — Continued

Item	Unit of measure	Loblolly		Slash		Longleaf		Shortleaf	
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Texture of 6–10 inch layer									
Sand	Percent	71	94	71	94	71	94	71	92
Silt	Percent	4	22	4	22	4	22	6	21
Clay	Percent	2	10	2	10	2	10	2	10
Texture of 16–20 inch layer									
Sand	Percent	64	96	64	96	64	96	74	95
Silt	Percent	2	24	2	24	2	24	3	16
Clay	Percent	2	13	2	13	2	13	2	13
Texture of 36–42 inch layer									
Sand	Percent	43	98	43	98	43	98	62	95
Silt	Percent	1	20	1	20	1	20	2	19
Clay	Percent	1	44	1	44	1	44	2	22

[1] By wet digestion without external heat.

[2] One-third atmosphere moisture percent minus 15 atmospheres moisture percent (by weight).

cluded. In addition, no loblolly, slash, or shortleaf plot was used for volume estimation if more than one-third of the trees present at age 2 or 3 had died from causes other than fusiform rust infection of the main bole.

Equations for predicting heights for different combinations of species and site were developed independently of each other; those for predicting yields were not. Only those yield equations that contained identical combinations of independent variables were considered in selecting the yield model.

Features of the sites that were screened for inclusion in the height equations are listed in table 1. Squared and cubed powers of many of these characteristics were also included in the analyses. The dependent variable in all equations was average height of dominant and codominant trees at 15 years. Heights for a few plots that were inventoried at ages 13, 14, and 16 were adjusted linearly to age 15 for these analyses.

In the yield analyses, equations were computed to predict both cubic foot volumes per acre (outside bark) and $\log_{10}$ of cubic foot volumes. Independent variables screened for inclusion in yield equations were:

1. 1/age of the plantation
2. number of trees per acre
3. (number of trees per acre)^2
4. $\log_{10}$ (number of trees per acre)
5. average height of dominant and codominant trees corresponding to the age in (1)
6. height^2
7. 1/height
8. height × number of trees
9. number of trees/height

For shortleaf pine, number of trees per acre was the total number present at age 2 or 3 years. For loblolly and slash pine, it was this number less the number killed by fusiform rust before age 15. For longleaf pine, the count was based on trees that were 0.6 inch in d.b.h. or larger at 10 years. Stocking at these ages were chosen because they were the earliest reliable density data available for predicting future yields.

About ⅓ of the loblolly and slash pine plots on wet and intermediate sites were reserved to test the accuracy of the height equations. No plots were withheld for testing the longleaf and shortleaf height equations or the yield equations of any species. Even so, too few plots were available for prediction of heights and yields of shortleaf pine on wet sites.

SITE-HEIGHT RELATIONSHIPS

Average heights of dominant and codominant trees on individual plots at 15 years ranged from 6.0 feet for loblolly pine on wet sites to 51.7 feet for loblolly and slash pine on intermediate sites (table 2). Features of the sites that were almost always associated with variations in height were average annual or growing-season rainfall, slope, and texture of one or more soil horizons (table 3). Percent organic matter in the A1 horizon was in three of the eleven equations. Thickness of the A horizon appeared in one equation.

Rainfall

Selected equations for wet and intermediate sites indicated that average height declined as average growing season (April through September) rainfall increased. On dry sites, height increased with rainfall. Heights of loblolly and slash pines on dry sites were more closely related to average annual than to average growing-season rainfall; heights of longleaf and shortleaf pines were more closely associated with growing-season rainfall. Because growing-season rainfall on the shortleaf plots ranged only from 50 to 52 inches and because the regression containing it was not reliable outside this range, rainfall was not included in the final shortleaf height-prediction equation for dry sites. In other equations, rainfall was the most important variable and accounted for 14 to 80 percent of the variation in stand height.

Using data from both the northern and southern hemispheres, Jackson (1962) found a negative relationship between spring and summer rainfall (March through August in the northern hemisphere) and slash pine site index in regions where annual rainfall averaged 50 inches or more. He attributed the response to inadequate soil aeration during the period of most active height growth. The relationship of rainfall and its seasonal distribution to tree height is probably more complex than Jackson imagined or the current analysis revealed. Even so, average growing-season rainfall appeared to be the best linear expression for precipitation to include in equations for wet and intermediate sites.

The positive correlation between rainfall and height on dry sites reflects the inability of these coarse-textured soils to store enough rain to sustain maximum growth.

Slope

All species grew taller on slightly sloping than on level ground. This response usually culminated at slopes of 4 percent or slightly less, and heights then declined as slopes steepened. In equations that showed no decrease in growth rate with increasing steepness, slopes greater than about 2 percent had little additional effect on predicted heights. Probably these curves would also have indicated decreased growth rate had sufficient data been available to develop precise relationships for slopes that were steep enough to promote rapid runoff. In an investigation of soil-site index relationships in south Arkansas and north Louisiana, Zahner (1958) found a slope of 1 percent was optimum for loblolly pine on azonal soils. On zonal soils, where slopes ranged from 1 to about 15 percent, site index of both loblolly and shortleaf pine declined as slope increased.

Texture

The eleven height-prediction equations contained 15 expressions of sand, silt, and clay con-

Table 2. — *Minimum and maximum heights at 15 years of dominant and codominant trees on plots used to develop and test site-height equations*

Species	Wet sites		Intermediate sites		Dry sites	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
			Feet			
Loblolly	6.0	48.5	13.2	51.7	28.1	51.0
Slash	9.8	48.0	24.6	51.7	26.2	50.7
Longleaf	12.2	37.3	15.5	49.0	22.8	41.6
Shortleaf			15.3	45.9	24.9	46.3

Table 3. — *Regression coefficients and fit statistics of equations for predicting heights (Y) at 15 years of loblolly, slash, longleaf, and shortleaf pine from characteristics of the planting sites*

Independent variable[1]	Loblolly pine equations			Slash pine equations			Longleaf pine equations			Shortleaf pine equations	
	Wet sites	Intermediate sites	Dry sites	Wet sites	Intermediate sites	Dry sites	Wet sites	Intermediate sites	Dry sites	Intermediate sites	Dry sites
Intercept	138.82737	66.37234	35.95367	−107.97629	78.03600	49.98179	24.93890	55.32675	−12.12675	72.92370	8.38767
Average annual rainfall			1.93577			1.37098					
Average growing season rainfall	−1.53805	−0.82076		−1.38391	−0.67130		−0.36493	−0.55602	1.95359	−1.06205	
Slope	−2.18553		−22.13124	−1.54534	−0.51229	−18.60307		−1.28046		−5.73806	6.78212
(Slope)^2			1.33415			1.12531				0.30603	−0.46811
1/Slope	−0.52352	−4.39776	−112.14813	−.87154	−8.44971	−105.33076	−0.42114		−10.71542	−25.78455	
Organic matter in A1 horizon	6.04812			4.85899				−6.32210			
(Organic matter in A1 horizon)^2								1.00576			
Thickness of A horizon								0.62222			
Sand 6–10 inch layer	−0.40005			2.05945						0.34769	
(Sand 6–10 inch layer)^2										−0.00387	
Silt 6–10 inch layer	−3.53898		−0.28145	1.45288					−1.76291		
(Silt 6–10 inch layer)^2	0.07454			.02011							
(Silt 6–10 inch layer)^3	−0.00055			−.00018							
(Clay 6–10 inch layer)^2				.05511							
Sand 16–20 inch layer	0.51652	−0.38763			−0.86062		1.11890			0.46119	
(Sand 16–20 inch layer)^2	−0.00572	0.01576			0.02449		−0.03433			−0.00366	
(Sand 16–20 inch layer)^3		−0.00015			−0.00020		0.00027				
Silt 16–20 inch layer						0.30501					
Clay 16–20 inch layer					−0.07292		0.85745				1.61440
(Clay 16–20 inch layer)^2					−0.00255		−0.02676				
(Clay 16–20 inch layer)^3					0.00003		0.00019				
Silt 36–42 inch layer									2.30328		
Clay 36–42 inch layer			0.14708						−0.57084		
N	47	97	27	52	92	27	36	86	17	79	17
R^2	0.80	0.43	0.82	0.76	0.42	0.72	0.74	0.43	0.94	0.53	0.77
RMSQR	0.2556	0.6041	0.2340	0.2910	0.6460	0.3456	0.3335	0.6059	0.0937	0.5225	0.2862
S.E. of estimate (± feet)	5.71	6.17	3.00	5.44	4.77	3.83	3.72	6.20	1.95	5.48	3.20

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[1] Units of measure are given in table 1. Slope percentages were increased by 0.1 to permit reciprocal of zero percentages to be computed.

tent of the soil, including the squared and cubed values needed to define curves for wet and intermediate sites. (Because of the small sample size, only linear relationships between height and textural variables were tested for dry sites.) Sand, silt, and clay percentages of the A horizon or of the 6- to 10-inch layer and of a deeper layer of soil (B2 horizon, 16- to 20-inch layer, or 36- to 42-inch layer) appeared in one or more equation. Only the longleaf equation for intermediate sites contained no textural variable.

In general, greater heights were predicted for trees on soils having loamy textures throughout the profile than for those on coarser- or finer-textured soils, if the curves were not extended beyond the limits of the original data (table 1). Others (Carmean 1975; Coile 1952, 1959; Jackson 1962; Zahner 1958) have reported similar relationships between soil texture and site index of pines.

Other soil properties

Percent organic matter in the A1 horizon was sufficiently well correlated with height to be included in three equations — the loblolly and slash pine equations for wet sites and the longleaf equation for intermediate sites. The wet-site equations indicated that heights increased with increasing organic matter. Probably organic matter improved structure and aeration of wet-site surface soils. On intermediate-site soils containing less than about 3 percent organic matter in the A1 horizon, longleaf pine heights increased as organic matter decreased. Since organic matter greatly enhances the ability of a soil to store water, this relationship may indicate that longleaf pine on these sites cannot compete well with other vegetation or with evaporation. That is, moisture from light summer showers retained near the soil surface is either used by other plants or evaporates.

Thickness of the A horizon was positively correlated with longleaf pine heights on intermediate sites and replaced textural variables in this equation.

Goodness of fit

The equations accounted for 74 to 80 percent of the variation in heights of dominant and codominant trees on wet sites, 42 to 53 percent of the variation on intermediate sites, and 72 to 94 percent of the variation on dry sites (table 3). The equations predicted 62 to 100 percent of the heights on which they were based within 5 feet and 90 to 100 percent within 10 feet (table 4). The loblolly and slash pine equations for wet and intermediate sites predicted 52 to 64 percent of the heights within 5 feet on plots reserved to test the equations.

HEIGHT-DENSITY-YIELD RELATIONSHIPS

Yield equations

The eight best equations for predicting total and merchantable yields of individual species contained four to nine independent variables, only one of which was common to all. These solutions obviously did not satisfy our objective of developing yield estimators having all independent variables in common. Inspection of relative mean squared residuals (RMSQR's) of equations having common X's revealed that those containing five independent variables listed in table 5 had ratios only slightly higher than the best equations. They were, moreover, the best compromise five-variable solution for the four species and two yield options. Equations that predicted $\log_{10}$ of total cubic foot volume per acre had lower RMSQR's than those that predicted actual total yields. Actual merchantable yields gave lower RMSQR's than their logarithms. Therefore $\log_{10}$ of total cubic foot volumes and actual merchantable cubic foot volumes were chosen as dependent variables for the equations.

Within the range of observed data (table 6), both total and merchantable yields of loblolly, slash, and longleaf pine increased with increasing numbers of trees and heights of the dominant stand. At heights greater than 38 feet, however, merchantable yield of shortleaf pine declined as stocking increased. Actually, the decrease was negligible as it amounted to only 4 cubic feet per acre per 100 additional trees if stands were 40 feet tall and 13 cubic feet per acre per 100 trees if stands were 45 feet tall.

Loblolly and slash pine yields declined as fusiform rust mortality increased. The assumption (inherent in the handling of fusiform rust mortality in the equations) that rust-killed trees had no impact on growth of survivors is probably erroneous. Careful inspection of differences

Table 4. — *Departures of observed from predicted heights in regression analyses*

Species site and sample	Differences between observed and predicted values of no more than:					
	± 2 feet	± 5 feet	± 10 feet	± 2 feet	± 5 feet	± 10 feet
	Number of observations			*Percentage of observations*		
Observations included in regression solutions						
Loblolly pine						
Wet sites	15	30	47	32	64	100
Intermediate sites	28	60	87	29	62	90
Dry sites	15	26	27	56	96	100
Slash pine						
Wet sites	15	34	50	29	65	96
Intermediate sites	29	64	91	32	70	99
Dry sites	8	24	27	30	89	100
Longleaf pine						
Wet sites	18	31	36	50	86	100
Intermediate sites	23	50	78	27	58	91
Dry sites	12	17	17	71	100	100
Shortleaf pine						
Wet sites						
Intermediate sites	18	58	75	23	73	95
Dry sites	11	15	17	65	88	100
Observations reserved to test solutions						
Loblolly pine						
Wet sites	4	14	21	16	56	84
Intermediate sites	13	29	44	29	63	96
Slash pine						
Wet sites	10	15	26	34	52	90
Intermediate sites	14	28	42	32	64	95

between predicted and observed yields, however, indicated that the equations predicted volume of plots that had low or high rust mortality about equally well. Thus, the equations appear to provide a reasonable first approximation of the impact of rust mortality on yields.

Age was not included as an independent variable in the chosen equations. The 2- or 3-year range in plantation age apparently had little impact on yields independent of its effect on stand height.

Goodness of fit and reliability of yield equations

Individual yield equations explained 75 to 95 percent of the variation in total and merchantable yields of the four species at 15 years (table 5). They predicted 55 to 79 percent of the values on which they were based within 300 cubic feet and 77 to 91 percent within 500 cubic feet (table 7). Fewer than 3 percent of predicted yields deviated more than 1,000 cubic feet from observed values.

Since yield equations are empirical solutions, they should not be applied beyond the range of data on which they are based. The range over which an individual equation is reliable is indicated by the filled cells in total and merchantable yield tables (table 8 and 9). Another factor restricting use of the equations is that they are based on data from plantations having an original planting spacing of 6 × 6 feet. Even though

Table 5. — *Regression coefficients and fit statistics for predicting cubic foot volumes (o.b.) per acre at 15 years (Y) from height (ft) of dominant and codominant trees and number of trees per acre*[1]

Independent variable	Loblolly pine equation		Slash pine equation		Longleaf pine equation		Shortleaf pine equation	
	Log$_{10}$ total volume	Actual merch. volume	Log$_{10}$ total volume	Actual merch. volume	Log$_{10}$ total volume	Actual merch. volume	Log$_{10}$ total volume	Actual merch. volume
Intercept	+1.49748	−8308.	+0.7798	−12818.	+3.2143	−2780.	+2.4443	−39.84
Ht of D & CD stand	+.07349	+190.57	+.091155	+365.9	−.003717	+62.98	+.07693	−16.54
Ht^2	−.000639	−.15744	−.000821	−2.1176	+.000154	+.05871	−.000732	+2.2213
1/Ht	−9.1488	+95771.	+.9878	+118117.	−18.626	+30471.	−40.996	−27738.
Trees per acre	+.000016	+1.1524	+.000209	+.81318	+.000588	+2.4832	−.00076	−.85687
Trees per acre/ht	.00987	−29.336	+.0041	−11.721	+.001149	−58.948	+.03716	+32.81
N	205	205	204	204	140	140	106	106
R^2	.94	.83	.89	.77	.89	.75	.95	.87
RMSQR	.0645	.1786	.1153	.2324	.1098	.2625	.0480	.1324
S.E. of estimate (ft^3)	+358.4 −309.7	±399.1	+414.6 −352.3	±435.6	+311.2 −225.8	±337.3	+353.6 −301.6	±359.4

[1] By species, the number of trees per acre for loblolly and slash is the established stand times (1.00-0.0P), where .0P is percent fusiform rust mortality through age 15; longleaf pine is the number of trees 0.6-inch d.b.h. and larger at age 10; and shortleaf is the number of trees in the established stand at age 2 or 3.

plantations contained as few as 444 established loblolly seedlings per acre, 568 established slash seedlings, 716 established shortleaf seedlings, and 514 longleaf seedlings in height growth at age 10, merchantable-yield equations may not be directly applicable to stands of these densities if the stands were achieved by planting more or fewer than 1,210 trees per acre. Total-yield equations more nearly reflect the potential of the site and probably apply to the range of densities represented by the data, regardless of planting spacing.

ESTIMATING YIELDS FROM CHARACTERISTICS OF THE SITE

For a predetermined number of trees per acre (see page 5), predicted yields of the four species on sites having specific characteristics may be computed by inserting heights obtained from solving equations in table 3 into corresponding species yield equations in table 5. Such solutions for an array of rainfall, slopes, soil textures, and tree densities are given separately by species as follows: (see Appendix)

Species	Wet sites	Intermediate sites	Dry sites
		Page no.	
Loblolly pine	18–25	26, 27	28, 29
Slash pine	30–33	34, 35	36
Longleaf pine	37, 38	39–44	45, 46
Shortleaf pine		47–52	52

Besides listing heights of dominant and codominant trees for each site condition, the tables contain estimates of total yield per acre in cubic feet (o.b.) and merchantable yield per acre in cubic feet (o.b.) and in standard cords. A volume of 91 cubic feet of wood and bark per cord was assumed in converting solid material to cords.

Average rainfall at a planting site can be obtained from U.S. Weather Service records. Slope and thickness of the A horizon can be measured directly. Sand, silt, clay, and organic matter percentages probably should be determined from laboratory analyses of soil samples. While experienced observers are able to esti-

Table 6.—*Average, minimum, and maximum observed values of selected stand characteristics of plots of the four major southern pine species used to develop yield equations*

Item	Unit of measure	Loblolly			Slash			Longleaf			Shortleaf		
		Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
Independent variables													
Age	Years		13	16		13	15	...	13	15	..	14	16
Average ht of dominant and codominant trees	Feet	37.8	13.2	51.7	39.3	14.4	51.7	30.8	12.2	49.0	34.0	6.0	46.3
Established stand per acre													
At age 2 or 3	Number	1,063	444	1,210	1,022	568	1,210	....	...	...	1,075	716	1,210
At age 10	Number	.	.	....	.	....	...	514	29	1,136	...	....	..
Fusiform rust mortality in established stand	Percent	6.8	0	36	11.0	0	52	....	....	....	..		..
Dependent variables													
Total volume	Ft³/Acre	2,578	290	4,453	2,573	272	4,648	1,165	25	3,704	2,442	49	4,295
Merchantable volume	Ft³/Acre	1,681	0	3,781	1,780	0	3,802	630	0	2,598	1,464	0	3,278

Table 7.—*Departures of observed from predicted yields per acre in regression analyses*

Species	Differences between observed and predicted values of no more than:							
	±100 ft³	±300 ft³	±500 ft³	±1000 ft³	±100 ft³	±300 ft³	±500 ft³	±1000 ft³
	Number of observations				*Percentage of observations*			
Total Yields								
Loblolly pine	54	126	173	204	26	61	84	100
Slash pine	46	112	158	201	23	55	77	99
Longleaf pine	57	110	128	137	41	79	91	98
Shortleaf pine	27	70	92	105	25	66	87	99
Merchantable Yields								
Loblolly pine	44	121	166	201	21	59	81	98
Slash pine	43	112	157	201	21	55	77	99
Longleaf pine	47	96	126	138	34	69	90	99
Shortleaf pine	31	72	92	106	29	68	87	100

mate particle size distribution within a few percentage points in the field, they may have difficulty estimating organic matter.

Numbers of trees per acre can be estimated from knowledge of planting survival, fusiform rust mortality, and the proportion of planted longleaf seedlings that survive and emerge from the grass stage by age 10. As an alternative for those who have no reliable local information, our experience in the current study is summarized below. Since some of our plots were interplanted after 1 year to replace trees that died and since numerous studies have shown (Wakeley 1954, Derr and Mann 1977) that few trees die in the 2d or 3d year from causes other than injury or disease, we summarized 1st year survival of the initial planting rather than 2d- or 3d-year stocking.

First-year survival varied by species, site, and year of planting. Over all sites and years, shortleaf pine survival averaged 78 percent, loblolly pine survival 77 percent, slash pine survival 69 percent, and longleaf pine survival 54 percent (table 10).

First-year survival of loblolly, slash, and longleaf pine was highest on wet and lowest on dry sites. Shortleaf pine survival, however, averaged 5 percentage points higher on intermediate than on wet sites, indicating that shortleaf was less tolerant of wet situations than the other species. Differences in survival from one year to another resulted from both differences in rainfall and differences in quality of the planting stock. Survival of all species was lower in 1956 than in other years. Throughout much of the two-State area, trees planted in 1956 received

Table 8. — *Predicted total volume per acre in stemwood and bark in trees 0.6-inch d.b.h. and larger at age 15 by number of trees,[1] height, and species*

Trees per acre	Height (feet)							
	15	20	25	30	35	40	45	50
				......Cubic Feet				
Loblolly pine								
600					1,601	2,206	2,809	3,309
800	243	459	791	1,253	1,836	2,490	3,130	3,651
1000	331	580	955	1,469	2,106	2,810	3,488	4,027
1200	451	733	1,154	1,722	2,415	3,171	3,887	4,443
Slash pine								
600						2,109	2,638	3,016
800			765	1,216	1,793	2,434	3,029	3,448
1000	324	547	908	1,426	2,084	2,809	3,478	3,943
1200	405	662	1,078	1,672	2,422	3,243	3,994	4,509
Longleaf pine								
300	142	291	460	643	845	1,075		
500		392	616	858	1,125	1,428	1,785	
700			825	1,145	1,497	1,897	2,368	2,942
900				1,528	1,993	2,520	3,142	
1100					2,652	3,348	4,167	
Shortleaf pine								
800					2,042	2,888	3,676	
1000	262	547	992	1,605	2,347	3,121	3,789	
1200	577	908	1,386	2,001	2,697	3,374	3,906	

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[1] The number of trees for loblolly and slash is the number present at age 2 or 3 less fusiform rust mortality through age 15, longleaf is the number of trees ≥ 0.6-inch d.b.h. at age 10, and shortleaf is the number of trees present at age 2 or 3.

substantially less April through September rainfall in their 1st year than those planted in other years.

Even though longleaf seedlings were sprayed twice annually with Bordeaux mixture for the first 5 years to control brown-spot needle disease, as few as 29 trees per acre and as many as 1,136 had emerged from the grass stage (were 0.6-inch d.b.h. or larger) by age 10 on plots that were included in the yield analysis. Wet-site plots averaged 478, intermediate-site plots 520, and dry-site plots 554 trees per acre. These numbers corresponded to 40, 43, and 46 percent of the seedlings that were planted. These stocking percentages are somewhat misleading, however, as longleaf pine had failed completely by age 10 on 28 percent of the plots in installations that had not been destroyed by wildfire or land clearing or abandoned because of site variability.

By age 15, fusiform rust had killed 6.8 percent of the loblolly pine and 11.0 percent of the slash pine seedlings that were present at age 2 or 3 (table 11). Rust mortality of both species was higher on intermediate than on wet or dry sites. Maximum mortality on an individual slash pine plot was 52 percent and on an individual loblolly pine plot was 36 percent. No clear relationship emerged between the year of planting and the proportion of trees that died from the disease by age 15.

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Table 9. — *Predicted merchantable volume (o.b.) per acre in trees 4.6 inches d.b.h. and larger to a 4-inch top at age 15 by number of trees*[1]*, height, and species.*

Trees per acre	Height (feet)											
	25	30	35	40	45	50	25	30	35	40	45	50
	Cubic feet						*Cords*[2]					
Loblolly pine												
600			1,094	1,708	2,377	3,081			12.0	18.8	26.1	33.9
800	172	599	1,157	1,792	2,477	3,195	1.9	6.6	12.7	19.7	27.2	35.1
1000	167	634	1,219	1,876	2,577	3 308	1.8	7.0	13.4	20.6	28.3	36.3
1200	163	669	1,282	1,960	2,677	3,421	1.8	7.4	14.1	21.5	29.4	37.6
Slash pine												
600				1,696	2,317	2,894				18.6	25.5	31.8
800	7	529	1,153	1,800	2,428	3,010	.1	5.8	12.7	19.8	26.7	33.1
1000	76	614	1,248	1,904	2,538	3,125	.8	6.7	13.7	20.9	27.9	34.3
1200	145	698	1,344	2,008	2,649	3,241	1.6	7.7	14.8	22.1	29.1	35.6
Longleaf pine												
300	88	334	607	898			1.0	3.7	6.7	9.9		
500	113	438	767	1,100	1,437		1.2	4.8	8.4	12.1	15.8	
700	138	541	926	1,302	1,672	2,039	1.5	5.9	10.2	14.3	18.4	22.4
900		645	1,086	1,504	1,906			7.1	11.9	16.5	20.9	
1100			1,246	1,706	2,141				13.7	18.7	23.5	
Shortleaf pine												
800			1,374	2,130	2,995				15.1	23.4	32.9	
1000	281	775	1,390	2,122	2,970		3.1	8.5	15.3	23.3	32.6	
1200	372	822	1,406	2,115	2,944		4.1	9.0	15.4	23.2	32.4	

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[1] The number of trees for loblolly and slash is the number present at age 2 or 3 less fusiform rust mortality through age 15, longleaf is the number of trees ≥ 0.6-inch d.b.h. at age 10, and shortleaf is the number of trees present at age 2 or 3.

[2] 91 ft^3 (o.b.) per cord.

Table 10. — *Average, minimum, and maximum first-year survival by species, site class, and year of planting*

Species and site class	Planted In														
	1954			1955			1956			1957-58			All Years		
	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
								Percent							
Loblolly pine	74	35	96	80	35	96	73	19	95	87	62	96	77	19	96
Wet	84	71	96	86	70	96	78	36	95	88	81	96	84	36	96
Intermediate	70	35	96	78	50	93	75	43	93	89	76	95	77	35	96
Dry				57	35	85	51	19	76	76	62	90	58	19	90
Slash pine	77	49	98	66	25	96	63	25	90	84	58	95	69	25	95
Wet	86	70	98	74	48	96	68	25	90	87	78	94	76	78	94
Intermediate	73	49	93	65	25	95	63	30	87	85	67	95	68	25	95
Dry				33	31	35	51	25	68	70	58	83	49	25	83
Longleaf pine	49	15	90	60	14	95	45	7	83	67	32	89	54	7	95
Wet	69	25	90	65	26	95	56	7	83	62	40	86	63	40	86
Intermediate	40	15	70	57	14	95	44	7	78	77	60	89	52	7	95
Dry				43	32	65	20	9	31	44	32	55	32	9	65
Shortleaf pine	87	69	96	82	33	98	70	43	91	80	58	92	78	33	98
Wet	93	93	93	88	77	98	56	55	56	74	58	91	75	55	98
Intermediate	86	69	96	86	71	96	71	43	91	87	79	92	80	43	96
Dry				62	33	91	76	63	90	82	71	92	73	33	92

Table 11. — *Average, minimum, and maximum fusiform rust mortality in established stands through age 15 by site class and year of planting*

Species and site class	Planted In												All Years		
	1954			1955			1956			1957					
	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
								Percent							
Loblolly pine	5.9	0	20	7.1	0	36	9.3	0	36	1.9	0	11	6.8	0	36
Wet	6.3	0	13	7.5	0	20	8.3	0	25	.6	0	4	6.0	0	25
Intermediate	5.8	0	20	8.1	0	36	12.2	0	36	2.5	0	11	8.2	0	36
Dry				1.1	0	6	1.2	0	4	2.7	2	4	1.3	0	6
Slash pine	7.4	0	26	11.8	0	52	12.8	0	51	10.7	0	45	11.0	0	52
Wet	3.8	0	11	9.7	0	32	8.2	0	25	4.6	0	9	7.5	0	32
Intermediate	8.7	0	26	13.6	0	52	15.8	0	51	16.0	0	45	13.3	0	52
Dry				8.7	0	18	9.8	2	20	7.8	3	14	8.8	0	18

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APPENDIX

Predicted Heights and Volumes

LOBLOLLY PINE
WET SITES
GROWING SEASON RAINFALL = 28 inches
ORGANIC MATTER = 0.5 percent

Texture of 6-10" layer		Sand in 16-20" layer	Trees /A	0 Percent Slope			1 Percent Slope			3 Percent Slope		
Sand	Silt			Total	Merchantable		Total	Merchantable		Total	Merchantable	
--*Percent*--		--*Percent*--	-*No.*-	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*
65	25	65		Ht 26.3 ft			Ht 28.8 ft			Ht 24.8 ft		
			800	898	266	2.9	1,130	482	5.3	775	158	1.7
			1000	1,075	273	3.0	1,333	509	5.6	937	152	1.7
			1200	1,287	281	3.1	1,572	535	5.9	1,134	146	1.6
		40		Ht 28.4 ft			Ht 30.9 ft			Ht 26.9 ft		
			800	1,091	445	4.9	1,350	692	7.6	951	314	3.4
			1000	1,290	469	5.2	1,575	732	8.0	1,134	326	3.6
			1200	1,524	492	5.4	1,838	773	8.5	1,353	339	3.7
		20		Ht 24.9 ft			Ht 27.5 ft			Ht 23.4 ft		
			800	783	165	1.8	1,005	364	4.0	670	77	0.8
			1000	946	160	1.8	1,195	382	4.2	820	56	0.6
			1200	1,144	155	1.7	1,420	399	4.4	1,003	36	0.4

LOBLOLLY PINE
WET SITES
GROWING SEASON RAINFALL = 28 inches
ORGANIC MATTER = 0.5 percent

Texture of 6-10" layer		Sand in 16-20" layer	Trees /A	0 Percent Slope			1 Percent Slope			3 Percent Slope		
Sand	Silt			Total	Merchantable		Total	Merchantable		Total	Merchantable	
--*Percent*--		--*Percent*--	-*No.*-	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*
40	40	40		Ht 31.3 ft			Ht 33.9 ft			Ht 29.8 ft		
			600	...	...	...	1,475	968	10.6	...	...	...
			800	1,394	734	8.1	1,699	1,026	11.3	1,232	579	6.4
			1000	1,624	777	8.5	1,957	1,083	11.9	1,446	613	6.7
			1200	1,892	820	9.0	2,254	1,141	12.5	1,696	646	7.1
		20		Ht 27.9 ft			Ht 30.4			Ht 26.4 ft		
			800	1,043	399	4.4	1,296	640	7.0	907	274	3.0
			1000	1,236	420	4.6	1,516	677	7.4	1,085	282	3.1
			1200	1,466	440	4.8	1,773	715	7.9	1,298	290	3.2
20	65	20		Ht 27.2 ft			Ht 29.8 ft			Ht 25.7 ft		
			800	978	339	3.7	1,232	579	6.4	847	221	2.4
			1000	1,164	354	3.9	1,446	613	6.7	1,019	223	2.4
			1200	1,386	368	4.0	1,696	646	7.1	1,224	225	2.5
	50	20		Ht 34.0 ft			Ht 36.6 ft			Ht 32.5 ft		
			600	1,486	980	10.8	1,789	1,283	14.1	...	...	...
			800	1,711	1,038	11.4	2,041	1,353	14.9	1,532	866	9.5
			1000	1,970	1,095	12.0	2,327	1,423	15.6	1,774	916	10.1
			1200	2,269	1,153	12.7	2,654	1,493	16.4	2,056	965	10.6

LOBLOLLY PINE
WET SITES
GROWING SEASON RAINFALL = 28 inches
ORGANIC MATTER = 2.5 percent

Texture of 6-10" layer		Sand in 16-20" layer	Trees /A	0 Percent Slope			1 Percent Slope			3 Percent Slope		
Sand	Silt			Total	Merchantable		Total	Merchantable		Total	Merchantable	
--*Percent*--		--*Percent*--	-*No.*-	-Ft^3-	-Ft^3-	*Cords*	-Ft^3-	-Ft^3-	*Cords*	-Ft^3-	-Ft^3-	*Cords*
65	25	65		Ht 38.4 ft			Ht 40.9 ft			Ht 36.9 ft		
			600	2,008	1,505	16.5	2,318	1,825	20.1	1,825	1,319	14.5
			800	2,277	1,582	17.4	2,609	1,912	21.0	2,080	1,391	15.3
			1000	2,582	1,660	18.2	2,937	1,999	22.0	2,370	1,462	16.1
			1200	2,928	1,738	19.1	3,306	2,086	22.9	2,700	1,534	16.9
		40		Ht 40.4 ft			Ht 43.0 ft			Ht 39.0 ft		
			600	2,256	1,760	19.3	2,575	2,105	23.1	2,083	1,580	17.4
			800	2,543	1,845	20.3	2,882	2,199	24.2	2,357	1,660	18.2
			1000	2,866	1,931	21.2	3,227	2,293	25.2	2,668	1,740	19.1
			1200	3,231	2,016	22.2	3,613	2,387	26.2	3,019	1,820	20.0
		20		Ht 37.0 ft			Ht 39.6 ft			Ht 35.5 ft		
			600	1,838	1,331	14.6	2,157	1,657	18.2	1,659	1,152	12.7
			800	2,093	1,402	15.4	2,437	1,739	19.1	1,899	1,217	13.4
			1000	2,384	1,475	16.2	2,753	1,821	20.0	2,174	1,282	14.1
			1200	2,715	1,547	17.0	3,110	1,904	20.9	2,489	1,348	14.8

LOBLOLLY PINE
WET SITES
GROWING SEASON RAINFALL = 28 inches
ORGANIC MATTER = 2.5 percent

Texture of 6-10" layer		Sand in 16-20" layer	Trees /A	0 Percent Slope			1 Percent Slope			3 Percent Slope		
Sand	Silt			Total	Merchantable		Total	Merchantable		Total	Merchantable	
--*Percent*--		--*Percent*--	-*No.*-	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*
40	40	40		Ht 43.4 ft			Ht 46.0 ft			Ht 42.0 ft		
			600	2,622	2,158	23.7	2,921	2,516	27.6	2,453	1,971	21.7
			800	2,933	2,254	24.8	3,247	2,619	28.8	2,753	2,061	22.7
			1000	3,281	2,349	25.8	3,611	2,721	29.9	3,090	2,152	23.6
			1200	3,670	2,444	26.9	4,015	2,824	31.0	3,469	2,243	24.6
		20		Ht 40.0 ft			Ht 42.6 ft			Ht 38.5 ft		
			600	2,206	1,708	18.8	2,526	2,051	22.5	2,021	1,517	16.7
			800	2,490	1,792	19.7	2,831	2,143	23.6	2,291	1,595	17.5
			1000	2,810	1,876	20.6	3,173	2,236	24.6	2,596	1,673	18.4
			1200	3,171	1,960	21.5	3,556	2,329	25.6	2,943	1,751	19.2
20	65	20		Ht 39.3 ft			Ht 41.9 ft			Ht 37.8 ft		
			600	2,120	1,618	17.8	2,441	1,957	21.5	1,935	1,430	15.7
			800	2,397	1,700	18.7	2,740	2,048	22.5	2,198	1,505	16.5
			1000	2,710	1,781	19.6	3,077	2,138	23.5	2,497	1,580	17.4
			1200	3,065	1,862	20.5	3,454	2,229	24.5	2,836	1,656	18.2
	50	20		Ht 46.1 ft			Ht 48.7 ft			Ht 44.6 ft		
			600	2,932	2,530	27.8	3,195	2,896	31.8	2,763	2,322	25.5
			800	3,259	2,633	28.9	3,533	3,006	33.0	3,082	2,421	26.6
			1000	3,623	2,736	30.1	3,907	3,116	34.2	3,438	2,520	27.7
			1200	4,027	2,839	31.2	4,320	3,226	35.4	3,834	2,619	28.8

LOBLOLLY PINE
WET SITES
GROWING SEASON RAINFALL = 38 inches
ORGANIC MATTER = 0.5 percent

Texture of 6-10" layer		Sand in 16-20" layer	Trees /A	0 Percent Slope			1 Percent Slope			3 Percent Slope		
Sand	Silt			Total	Merchantable		Total	Merchantable		Total	Merchantable	
--*Percent*--		--*Percent*--	-*No.*-	-Ft^3-	-Ft^3-	*Cords*	-Ft^3-	-Ft^3-	*Cords*	-Ft^3-	-Ft^3-	*Cords*
65	25	65		Ht 10.9 ft			Ht 13.4 ft			Ht 9.4 ft		
			800	...	...	...	193	...	...	...	...	...
			1000	...	...	...	274	...	...	...	...	...
			1200	...	...	...	387	...	...	...	...	...
		40		Ht 13.0 ft			Ht 15.6 ft			Ht 11.5 ft		
			800	182	...	...	263	...	...	...	...	...
			1000	261	...	...	355	...	...	...	...	...
			1200	372	...	...	479	...	...	...	...	...
		20		Ht 9.5 ft			Ht 12.1 ft			Ht 8.0 ft		

(Predicted heights below lower limits of reliability of yield equations.)

LOBLOLLY PINE
WET SITES
GROWING SEASON RAINFALL = 38 inches
ORGANIC MATTER = 0.5 percent

Texture of 6-10" layer		Sand in 16-20" layer	Trees /A	0 Percent Slope			1 Percent Slope			3 Percent Slope		
Sand	Silt			Total	Merchantable		Total	Merchantable		Total	Merchantable	
--*Percent*--		--*Percent*--	-*No.*-	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*
40	40	40		Ht 16.0 ft			Ht 18.5 ft			Ht 14.5 ft		
			800	278	...	...	383	...	...	226	...	...
			1000	372	...	...	493	...	...	312	...	...
			1200	498	...	...	635	...	...	430	...	...
		20		Ht 12.5 ft			Ht 15.1 ft			Ht 11.0 ft		
			800	...	...	...	246	...	...	...	...	...
			1000	...	...	...	335	...	...	...	...	...
			1200	...	...	...	456	...	...	...	...	...
20	65	20		Ht 11.8 ft			Ht 14.4 ft			Ht 10.4 ft		
			800	...	...	...	223	...	...	...	...	...
			1000	...	...	...	308	...	...	...	...	...
			1200	...	...	...	426	...	...	...	...	...
	50	20		Ht 18.6 ft			Ht 21.2 ft			Ht 17.2 ft		
			800	388	...	...	527	...	...	325	...	...
			1000	499	...	...	658	...	...	427	...	...
			1200	641	...	...	821	...	...	560	...	...

LOBLOLLY PINE
WET SITES
GROWING SEASON RAINFALL = 38 inches
ORGANIC MATTER = 2.5 percent

Texture of 6-10" layer		Sand in 16-20" layer	Trees /A	0 Percent Slope			1 Percent Slope			3 Percent Slope		
Sand	Silt			Total	Merchantable		Total	Merchantable		Total	Merchantable	
--*Percent*--		--*Percent*--	-*No.*-	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*
65	25	65		Ht 23.0 ft			Ht 25.5 ft			Ht 21.5 ft		
			800	643	57	0.6	831	206	2.3	545	...	...
			1000	789	32	0.4	1,000	207	2.3	678	...	...
			1200	968	8	0.1	1,204	207	2.3	844	...	...
		40		Ht 25.1 ft			Ht 27.6 ft			Ht 23.6 ft		
			800	798	178	2.0	1,015	373	4.1	685	87	1.0
			1000	964	175	1.9	1,205	391	4.3	836	69	0.8
			1200	1,164	172	1.9	1,431	409	4.5	1,021	51	0.6
		20		Ht 21.6 ft			Ht 24.2 ft			Ht 20.1 ft		
			800	551	...	...	729	121	1.3	464	...	...
			1000	685	...	...	886	109	1.2	586	...	...
			1200	852	...	...	1,077	97	1.1	740	...	...

LOBLOLLY PINE
WET SITES
GROWING SEASON RAINFALL = 38 inches
ORGANIC MATTER = 2.5 percent

Texture of 6-10" layer		Sand in 16-20" layer	Trees /A	0 Percent Slope			1 Percent Slope			3 Percent Slope		
Sand	Silt			Total	Merchantable		Total	Merchantable		Total	Merchantable	
--*Percent*--		--*Percent*--	-*No.*-	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*
40	40	40		Ht 28.1 ft			Ht 30.6 ft			Ht 26.6 ft		
			800	1,062	417	4.6	1,317	660	7.3	924	290	3.2
			1000	1,257	439	4.8	1,539	699	7.2	1,104	299	3.3
			1200	1,489	461	5.1	1,799	738	8.1	1,320	309	3.4
		20		Ht 24.6 ft			Ht 27.2 ft			Ht 23.1 ft		
			800	759	145	1.6	978	339	3.7	649	62	0.7
			1000	920	137	1.5	1,164	354	3.9	796	38	0.4
			1200	1,115	129	1.4	1,386	368	4.0	977	15	0.2
20	65	20		Ht 23.9 ft			Ht 26.5 ft			Ht 22.4 ft		
			800	707	104	1.1	915	282	3.1	602	...	...
			1000	861	89	1.0	1,095	291	3.2	743	...	...
			1200	1,049	73	0.8	1,309	300	3.3	917	...	...
	50	20		Ht 30.7 ft			Ht 33.3 ft			Ht 29.2 ft		
			600	...	...	...	1,409	902	9.9	...	...	...
			800	1,328	671	7.4	1,626	956	10.5	1,170	520	5.7
			1000	1,551	710	7.8	1,878	1,011	11.1	1,378	550	6.0
			1200	1,812	750	8.2	2,168	1,065	11.7	1,621	579	6.4

LOBLOLLY PINE
INTERMEDIATE SITES
GROWING SEASON RAINFALL = 28 inches

Sand in B2 horizon	Trees /A	1 Percent Slope			3 Percent Slope			5 Percent Slope			7 Percent Slope		
		Total	Merchantable		Total	Merchantable		Total	Merchantable		Total	Merchantable	
--*Percent*--	-*No.*-	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*
75		Ht 35.3 ft			Ht 38.2 ft			Ht 38.8 ft			Ht 39.1 ft		
	600	1,635	1,129	12.4	1,984	1,480	16.3	2,058	1,555	17.1	2,095	1,593	17.5
	800	1,874	1,193	13.1	2,251	1,556	17.1	2,330	1,634	18.0	2,370	1,673	18.4
	1000	2,147	1,257	13.8	2,554	1,633	17.9	2,639	1,713	18.8	2,682	1,754	19.3
	1200	2,459	1,321	14.5	2,897	1,710	18.8	2,989	1,793	19.7	3,034	1.834	20.2
55		Ht 40.4 ft			Ht 43.3 ft			Ht 43.9 ft			Ht 44.2 ft		
	600	2,256	1.760	19.3	2,610	2,145	23.6	2,682	2,226	24.5	2,717	2,267	24.9
	800	2,543	1,845	20.3	2,921	2,240	24.6	2,996	2,323	25.5	3,033	2,365	26.0
	1000	2,866	1,931	21.2	3,267	2,335	25.7	3,347	2,420	26.6	3,386	2,463	27.1
	1200	3,231	2,016	22.2	3,656	2,430	26.7	3,739	2,517	27.7	3,780	2,561	28.1
35		Ht 38.3 ft			Ht 41.2 ft			Ht 41.8 ft			Ht 42.1 ft		
	600	1,996	1,492	16.4	2,355	1,865	20.5	2,429	1,944	21.4	2,465	1,984	21.8
	800	2,264	1,569	17.2	2,649	1,953	21.5	2,727	2,034	22.4	2,766	2,075	22.8
	1000	2,568	1,647	18.1	2,979	2,041	22.4	3,063	2,124	23.3	3,104	2,166	23.8
	1200	2,913	1,724	18.9	3,351	2,129	23.4	3,440	2,214	24.3	3,483	2,257	24.8
15		Ht 36.2 ft			Ht 39.2 ft			Ht 39.8 ft			Ht 40.0 ft		
	600	1,742	1,235	13.6	2,107	1,606	17.6	2,182	1,683	18.5	2,206	1,708	18.8
	800	1,989	1,303	14.3	2,384	1,687	18.5	2,463	1,766	19.4	2,490	1,792	19.7
	1000	2,271	1,372	15.1	2,696	1,767	19.4	2,781	1,849	20.3	2,810	1,876	20.6
	1200	2,594	1,440	15.8	3,050	1,848	20.3	3,141	1,932	21.2	3,171	1,960	21.5

LOBLOLLY PINE
INTERMEDIATE SITES
GROWING SEASON RAINFALL = 38 inches

Sand in B2 horizon	Trees /A	1 Percent Slope			3 Percent Slope			5 Percent Slope			7 Percent Slope		
		Total	Merchantable		Total	Merchantable		Total	Merchantable		Total	Merchantable	
--*Percent*--	-*No.*-	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*
75		Ht 27.1 ft			Ht 30.0 ft			Ht 30.6 ft			Ht 30.9 ft		
	800	969	330	3.6	1,253	599	6.6	1,317	660	7.3	1,350	692	7.6
	1000	1,154	344	3.8	1,469	634	7.0	1,539	699	7.7	1,575	732	8.0
	1200	1,375	358	3.9	1,722	669	7.4	1,799	738	8.1	1,838	773	8.5
55		Ht 32.2 ft			Ht 35.1 ft			Ht 35.7 ft			Ht 36.0 ft		
	600	...	...	...	1,612	1,105	12.1	1,682	1,176	12.9	1,718	1,211	13.3
	800	1,497	832	9.1	1,848	1,169	12.8	1,925	1,242	13.6	1,963	1,279	14.0
	1000	1,736	880	9.7	2,119	1,232	13.5	2,202	1,308	14.4	2,244	1,346	14.8
	1200	2,014	929	10.2	2,430	1,295	14.2	2,519	1,374	15.1	2,564	1,414	15.5
35		Ht 30.1 ft			Ht 33.0 ft			Ht 33.6 ft			Ht 33.9 ft		
	600	...	...	...	1,376	869	9.6	1,442	935	10.3	1,475	968	10.6
	800	1,264	609	6.7	1,591	922	10.1	1,663	991	10.9	1,699	1,026	11.3
	1000	1,481	645	7.1	1,839	975	10.7	1,917	1,047	11.5	1,957	1,083	11.9
	1200	1,734	680	7.5	2,126	1,027	11.3	2,211	1,103	12.1	2,254	1,141	12.5
15		Ht 28.0 ft			Ht 30.9 ft			Ht 31.5 ft			Ht 31.8 ft		
	800	1,052	408	4.5	1,350	692	7.6	1,417	756	8.3	1,451	788	8.7
	1000	1,247	429	4.7	1,575	732	8.0	1,649	800	8.8	1,686	834	9.2
	1200	1,477	450	4.9	1,838	773	8.5	1,918	844	9.3	1,959	880	9.7

LOBLOLLY PINE
DRY SITES
ANNUAL RAINFALL = 46 inches

Silt in 6-10" layer	Clay in 36-42" layer	Trees /A	2 Percent Slope			5 Percent Slope		
			Total	Merchantable		Total	Merchantable	
--*Percent*--	--*Percent*--	*-No.-*	*-Ft^3-*	*-Ft^3-*	*Cords*	*-Ft^3-*	*-Ft^3-*	*Cords*
5	3		Ht 29.0 ft			Ht 24.3 ft		
		800	1,150	501	5.5	736	127	1.4
		1000	1,355	529	5.8	894	116	1.3
		1200	1,597	557	6.1	1,086	105	1.2
	6		Ht 29.5 ft			Ht 24.7 ft		
		800	1,201	549	6.0	767	152	1.7
		1000	1,411	581	6.4	929	145	1.6
		1200	1,658	613	6.7	1,124	138	1.5
	15		Ht 30.8 ft			Ht 26.1 ft		
		800	1,339	681	7.5	881	250	2.8
		1000	1,563	721	7.9	1,056	256	2.8
		1200	1,825	761	8.4	1,266	262	2.9
10	6		Ht 28.1 ft			Ht 23.4 ft		
		800	1,062	417	4.6	670	77	0.8
		1000	1,257	439	4.8	820	56	0.6
		1200	1,489	461	5.1	1,003	36	0.4
	15		Ht. 29.4 ft			Ht 24.7 ft		
		800	1,191	540	5.9	767	152	1.7
		1000	1,400	570	6.3	929	145	1.6
		1200	1,646	601	6.6	1,124	138	1.5

LOBLOLLY PINE
DRY SITES
ANNUAL RAINFALL = 56 inches

Silt in 6-10" layer	Clay in 36-42" layer	Trees /A	2 Percent Slope			5 Percent Slope		
			Total	Merchantable		Total	Merchantable	
--Percent--	*--Percent--*	*-No.-*	*-Ft^3-*	*-Ft^3-*	*Cords*	*-Ft^3-*	*-Ft^3-*	*Cords*
				Ht 48.4 ft			Ht 43.7 ft	
5	3	600	3,167	2,853	31.4	2,658	2,199	24.2
		800	3,504	2,962	32.6	2,971	2,295	25.2
		1000	3,877	3,072	33.8	3,321	2,392	26.3
		1200	4,290	3,181	35.0	3,711	2,488	27.3
	6			Ht 48.8 ft			Ht 44.1 ft	
		600	3,204	2,910	32.0	2,705	2,254	24.8
		800	3,542	3,020	33.2	3,021	2,351	25.8
		1000	3,917	3,130	34.4	3,373	2.449	26.9
		1200	4,330	3,241	35.6	3,767	2,546	28.0
	15			Ht 50.2 ft			Ht 45.4 ft	
		600	3,326	3,110	34.2	2,854	2,432	26.7
		800	3,667	3,224	35.4	3.178	2,534	27.8
		1000	4,044	3,337	36.7	3,538	2,635	29.0
		1200	4,460	3,451	37.9	3,939	2,736	30.1
10	6			Ht 47.5 ft			Ht 42.7 ft	
		600	3,078	2,726	30.0	2,538	2,064	22.7
		800	3,412	2,833	31.1	2,844	2,157	23.7
		1000	3,782	2,940	32.3	3,186	2,250	24.7
		1200	4,192	3,047	33.5	3,570	2,343	25.8
	15			Ht 48.8 ft			Ht 44.0 ft	
		600	3,204	2,910	32.0	2,693	2,240	24.6
		800	3,542	3,020	33.2	3,008	2,337	25.7
		1000	3,917	3,130	34.4	3,360	2,434	26.8
		1200	4,330	3.241	35.6	3,753	2,531	27.8

SLASH PINE
WET SITES
GROWING SEASON RAINFALL = 28 inches
ORGANIC MATTER = 0.5 percent

Texture of 6-10" layer			Trees	0 Percent Slope			1 Percent Slope			3 Percent Slope		
Sand	Silt	Clay	/A	Total	Merchantable		Total	Merchantable		Total	Merchantable	
---*Percent*----			*-No.-*	*-Ft^3-*	*-Ft^3-*	*Cords*	*-Ft^3-*	*-Ft^3-*	*Cords*	*-Ft^3-*	*-Ft^3-*	*Cords*
65	25	10		Ht 32.3 ft			Ht 38.7 ft			Ht 36.1 ft		
			600	...	...	...	1,961	1,530	16.8	...	...	...
			800	1,469	809	8.9	2,267	1,632	17.9	1,932	1,295	14.2
			1000	1,714	899	9.9	2,621	1,734	19.1	2,241	1,393	15.3
			1200	2,001	989	10.9	3,030	1,836	20.2	2,600	1,490	16.4
40	40	20		Ht 30.0 ft			Ht 36.4 ft			Ht 33.8 ft		
			800	1,216	529	5.8	1,970	1,334	14.7	1,646	999	11.0
			1000	1,426	614	6.7	2,285	1,432	15.7	1,916	1,092	12.0
			1200	1,672	698	7.7	2,650	1,530	16.8	2,231	1,185	13.0
20	65	15		Ht 30.4 ft			Ht 36.8 ft			Ht 34.2 ft		
			800	1,258	577	6.3	2,021	1,386	15.2	1,695	1,050	11.5
			1000	1,474	662	7.3	2,343	1,485	16.3	1,972	1,144	12.6
			1200	1,727	748	8.2	2,716	1,584	17.4	2,294	1,238	13.6
20	50	30		Ht 38.0 ft			Ht 44.4 ft			Ht 41.8 ft		
			600	1,881	1,441	15.8	2,580	2,244	24.7	2,309	1,923	21.1
			800	2,176	1,542	16.9	2,964	2,354	25.9	2,660	2,030	22.3
			1000	2,518	1,642	18.0	3,406	2,464	27.1	3,064	2,136	23.5
			1200	2,914	1,743	19.2	3,913	2,574	28.3	3,530	2,243	24.6

SLASH PINE
WET SITES
GROWING SEASON RAINFALL = 28 inches
ORGANIC MATTER = 2.5 percent

Texture of 6-10" layer			Trees	0 Percent Slope			1 Percent Slope			3 Percent Slope		
Sand	Silt	Clay	/A	Total	Merchantable		Total	Merchantable		Total	Merchantable	
---Percent----			-No.-	-Ft^3-	-Ft^3-	Cords	-Ft^3-	-Ft^3-	Cords	-Ft^3-	-Ft^3-	Cords
65	25	10		Ht 42.0 ft			Ht 48.4 ft			Ht 45.8 ft		
			600	2,331	1,948	21.4	2,918	2,715	29.8	2,712	2,413	26.5
			800	2,685	2,055	22.6	3,341	2,830	31.1	3,111	2,524	27.7
			1000	3,092	2,162	23.8	3,825	2,944	32.3	3,570	2,636	29.0
			1200	3,561	2,269	24.9	4,379	3,058	33.6	4,096	2,747	30.2
40	40	20		Ht 39.7 ft			Ht 46.1 ft			Ht 43.5 ft		
			600	2,075	1,658	18.2	2,738	2,448	26.9	2,490	2,134	23.5
			800	2,396	1,761	19.4	3,141	2,560	28.1	2,863	2,243	24.6
			1000	2,766	1,865	20.5	3,603	2,672	29.4	3,292	2,352	25.8
			1200	3,194	1,968	21.6	4,133	2,784	30.6	3,786	2,461	27.0
20	65	15		Ht 40.1 ft			Ht 46.5 ft			Ht 43.9 ft		
			600	2,120	1,709	18.8	2,772	2,496	27.4	2,531	2,183	24.0
			800	2,447	1,813	19.9	3,179	2,608	28.7	2,909	2,293	25.2
			1000	2,824	1.917	21.1	3,645	2,720	29.9	3,343	2,402	26.4
			1200	3,259	2,021	22.2	4,180	2,832	31.1	3,843	2,511	27.6
20	50	30		Ht 47.8 ft			Ht 54.1 ft			Ht 51.6 ft		
			600	2,875	2,647	29.1	3,144	3,322	36.5	3,088	3,066	33.7
			800	3,294	2,760	30.3	3,585	3,441	37.8	3,527	3,184	35.0
			1000	3,772	2,874	31.6	4,087	3,561	39.1	4,028	3,301	36.3
			1200	4,321	2,988	32.8	4,660	3,680	40.4	4,600	3,418	37.6

SLASH PINE
WET SITES
GROWING SEASON RAINFALL = 38 inches
ORGANIC MATTER = 0.5 percent

Texture of 6-10" layer			Trees	0 Percent Slope			1 Percent Slope			3 Percent Slope		
Sand	Silt	Clay	/A	Total	Merchantable		Total	Merchantable		Total	Merchantable	
---Percent----			-No.-	-Ft^3-	-Ft^3-	Cords	-Ft^3-	-Ft^3-	Cords	-Ft^3-	-Ft^3-	Cords
65	25	10		Ht 18.4 ft			Ht 24.8 ft			Ht 22.2 ft		
			800	...	...	...	750	-10	-0.1	...	...	...
			1000	462	...	...	891	58	.6	687	...	...
			1200	564	...	...	1,058	126	1.4	824	...	...
40	40	20		Ht 16.2 ft			Ht 22.6 ft			Ht 20.0 ft		
			800	...	...	...	598	-167	-1.8	...	...	...
			1000	367	...	...	716	-109	-1.2	547	...	...
			1200	454	...	...	857	-50	-.5	662	...	...
20	65	15		Ht 16.6 ft			Ht 22.9 ft			Ht 20.4 ft		
			800	...	...	...	617	-150	-1.6	...	...	...
			1000	382	...	...	738	-90	-1.0	570	...	...
			1200	472	...	...	882	-29	-0.3	689	...	...
20	50	30		Ht 24.2 ft			Ht 30.6 ft			Ht 28.0 ft		
			800	706	-59	-0.6	1,280	601	6.6	1,019	302	3.3
			1000	840	7	.1	1,499	687	7.5	1,200	381	4.2
			1200	1,000	73	.8	1,755	773	8.5	1,414	460	5.1

SLASH PINE
WET SITES
GROWING SEASON RAINFALL = 38 inches
ORGANIC MATTER = 2.5 percent

Texture of 6-10" layer			Trees	0 Percent Slope			1 Percent Slope			3 Percent Slope		
Sand	Silt	Clay	/A	Total	Merchantable		Total	Merchantable		Total	Merchantable	
---*Percent*----			-*No.*-	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*
65	25	10		Ht 28.2 ft			Ht 34.5 ft			Ht 32.0 ft		
			800	1,038	324	3.6	1,731	1,088	12.0	1,434	772	8.5
			1000	1,222	403	4.4	2,014	1,183	13.0	1,675	862	9.5
			1200	1,438	483	5.3	2,342	1,278	14.0	1,957	951	10.4
40	40	20		Ht 25.9 ft			Ht 32.3 ft			Ht 29.7 ft		
			800	836	88	1.0	1,469	809	8.9	1,185	494	5.4
			1000	990	160	1.8	1,714	899	9.9	1,391	578	6.3
			1200	1,172	232	2.6	2,001	989	10.9	1,632	661	7.3
20	65	15		Ht 26.3 ft			Ht 32.6 ft			Ht 30.1 ft		
			800	869	126	1.4	1,503	847	9.3	1,227	541	5.9
			1000	1,028	200	2.2	1,754	938	10.3	1,438	626	6.9
			1200	1,216	273	3.0	2,046	1,028	11.3	1,686	710	7.8
20	50	30		Ht 33.9 ft			Ht 40.3 ft			Ht 37.7 ft		
			600	...	...	...	2,143	1,734	19.1	1,846	1,402	15.4
			800	1,658	1,012	11.1	2,472	1,838	20.2	2,137	1,503	16.5
			1000	1,930	1,105	12.1	2,853	1,943	21.4	2,474	1,603	17.6
			1200	2,247	1,198	13.2	3,292	2,047	22.5	2,864	1,704	18.7

SLASH PINE
INTERMEDIATE SITES
GROWING SEASON RAINFALL = 28 inches

Texture of B2 horizon		Trees	1 Percent Slope			3 Percent Slope			5 Percent Slope			7 Percent Slope		
Sand	Clay	/A	Total	Merchantable		Total	Merchantable		Total	Merchantable		Total	Merchantable	
--*Percent*-		-*No.*-	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*
75	10		Ht 38.2 ft			Ht 42.8 ft			Ht 42.9 ft			Ht 42.3 ft		
		600	1,904	1,466	16.1	2,417	2,048	22.5	2,428	2,060	22.6	2,364	1,986	21.8
		800	2,202	1,567	17.2	2,781	2,156	23.7	2,793	2,168	23.8	2,721	2,093	23.0
		1000	2,547	1,669	18.3	3,200	2,264	24.9	3,214	2,276	25.0	3,133	2,200	24.2
		1200	2,947	1,770	19.5	3,683	2,372	26.1	3,698	2,384	26.2	3,607	2,307	25.4
55	15		Ht 42.2 ft			Ht 46.8 ft			Ht 46.9 ft			Ht 46.4 ft		
		600	2,353	1,973	21.7	2,797	2,531	27.8	2,806	2,543	27.9	2,764	2,484	27.3
		800	2,709	2,080	22.9	3,207	2,643	29.0	3,215	2,655	29.2	3,170	2,596	28.5
		1000	3,119	2,187	24.0	3,676	2,756	30.3	3,686	2,768	30.4	3,635	2,708	29.8
		1200	3,592	2,295	25.2	4,214	2,868	31.5	4,226	2,881	31.7	4,168	2,820	31.0
35	35		Ht 37.2 ft			Ht 41.8 ft			Ht 41.9 ft			Ht 41.4 ft		
		600	....	...	...	2,309	1,923	21.1	2,320	1,936	21.3	2,265	1,873	20.6
		800	2,073	1,438	15.8	2,660	2,030	22.3	2,673	2,042	22.4	2,611	1,979	21.7
		1000	2,401	1,537	16.9	3,064	2,136	23.5	3,078	2,149	23.6	3,009	2,085	22.9
		1200	2,782	1,637	18.0	3,530	2,243	24.6	3,545	2,256	24.8	3,467	2,191	24.1
15	15		Ht 40.6 ft			Ht 45.2 ft			Ht 45.3 ft			Ht 44.8 ft		
		600	2,176	1,772	19.5	2,657	2,341	25.7	2,666	2,353	25.9	2,619	2,293	25.2
		800	2,510	1,877	20.6	3,050	2,452	26.9	3,060	2,464	27.1	3,008	2,403	26.4
		1000	2,896	1,982	21.8	3,502	2,563	28.2	3,513	2,575	28.3	3,454	2,514	27.6
		1200	3,340	2,087	22.9	4,020	2,673	29.4	4,033	2,686	29.5	3,967	2,624	28.8
	35		Ht 37.8 ft			Ht 42.4 ft			Ht 42.5 ft			Ht 42.0 ft		
		600	1,858	1,415	15.5	2,374	1,998	22.0	2,385	2,011	22.1	2,331	1,948	21.4
		800	2,150	1,516	16.7	2,733	2,106	23.1	2,745	2,118	23.3	2,685	2,055	22.6
		1000	2,489	1,616	17.8	3,147	2,213	24.3	3,160	2,226	24.5	3,092	2,162	23.8
		1200	2,881	1,717	18.9	3,622	2,320	25.5	3,637	2,333	25.6	3,561	2,269	24.9
	50		Ht. 35.9 ft			Ht 40.5 ft			Ht 40.6 ft			Ht 40.1 ft		
		600	...	...	...	2,165	1,759	19.3	2,176	1,772	19.5	2,120	1,709	18.8
		800	1,907	1,269	13.9	2,498	1,864	20.5	2,510	1,877	20.6	2,447	1,813	19.9
		1000	2,213	1,366	15.0	2,881	1,969	21.6	2,896	1,982	21.8	2,824	1,917	21.1
		1200	2,568	1,464	16.1	3,324	2,074	22.8	3,340	2,087	22.9	3.259	2.021	22.2

SLASH PINE
INTERMEDIATE SITES
GROWING SEASON RAINFALL = 38 inches

Texture of B2 horizon		Trees	1 Percent Slope			3 Percent Slope			5 Percent Slope			7 Percent Slope		
Sand	Clay	/A	Total	Merchantable		Total	Merchantable		Total	Merchantable		Total	Merchantable	
--*Percent*-		-*No.*-	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*
75	10		Ht 31.4 ft			Ht 36.1 ft			Ht 36.2 ft			Ht 35.6 ft		
		800	1,367	698	7.7	1,932	1,295	14.2	1,945	1,308	14.4	1,869	1,230	13.5
		1000	1,598	786	8.6	2,241	1,393	15.3	2,256	1,406	15.4	2,170	1,327	14.6
		1200	1,869	874	9.6	2,600	1,490	16.4	2,617	1,504	16.5	2,519	1,424	15.6
55	15		Ht 35.5 ft			Ht 40.1 ft			Ht 40.2 ft			Ht 39.6 ft		
		600	...	...	...	2,120	1,709	18.8	2,131	1,721	18.9	2,063	1,645	18.1
		800	1,856	1,217	13.4	2,447	1,813	19.9	2,460	1,826	20.1	2,383	1,748	19.2
		1000	2,155	1,314	14.4	2,824	1,917	21.1	2,838	1,930	21.2	2,752	1,852	20.4
		1200	2,503	1,411	15.5	3,259	2,021	22.2	3,275	2,034	22.4	3,178	1,955	21.5
35	35		Ht 30.5 ft			Ht 35.1 ft			Ht 35.2 ft			Ht 34.6 ft		
		800	1,269	589	6.5	1,806	1,166	12.8	1,818	1,179	13.0	1,744	1,101	12.1
		1000	1,486	674	7.4	2,098	1,262	13.9	2,112	1,275	14.0	2,028	1,196	13.1
		1200	1,741	760	8.4	2,438	1,357	14.9	2,454	1,371	15.1	2,358	1,291	14.2
15	15		Ht 33.9 ft			Ht 38.5 ft			Ht 38.6 ft			Ht 38.1 ft		
		600	...	...	...	1,938	1,505	16.5	1,949	1,517	16.7	1,892	1,453	16.0
		800	1,658	1,012	11.1	2,241	1,606	17.7	2,254	1,619	17.8	2,189	1,554	17.1
		1000	1,930	1,105	12.1	2,591	1,708	18.8	2,606	1,721	18.9	2,533	1,656	18.2
		1200	2,247	1,199	13.2	2,997	1,810	19.9	3,013	1,823	20.0	2,930	1,757	19.3
	35		Ht 31.1 ft			Ht 35.7 ft			Ht 35.8 ft			Ht 35.3 ft		
		800	1,334	661	7.3	1,881	1,243	13.7	1,894	1,256	13.8	1,831	1,192	13.1
		1000	1,561	748	8.2	2,184	1,340	14.7	2,198	1,353	14.9	2,127	1,288	14.2
		1200	1,826	836	9.2	2,535	1,437	15.8	2,551	1,450	15.9	2,470	1,384	15.2
	50		Ht 29.2 ft			Ht 33.8 ft			Ht 33.9 ft			Ht 33.4 ft		
		800	1,135	436	4.8	1,646	999	11.0	1,658	1,012	11.1	1,598	948	10.4
		1000	1,333	518	5.7	1,916	1,092	12.0	1,930	1,105	12.1	1,862	1,040	11.4
		1200	1,566	601	6.6	2,231	1,185	13.0	2,247	1,198	13.2	2,169	1,133	12.4

SLASH PINE
DRY SITES
ANNUAL RAINFALL = 46 inches

Silt in 16-20" layer	Trees /A	2 Percent Slope			5 Percent Slope		
		Total	Merchantable		Total	Merchantable	
--*Percent*---	-*No.*-	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*
5		Ht 29.2 ft			Ht 28.6 ft		
	800	1,135	436	4.8	1,076	368	4.0
	1000	1,333	518	5.7	1,265	449	4.9
	1200	1,566	601	6.6	1,488	529	5.8
10		Ht 30.7 ft			Ht 30.1 ft		
	800	1,290	613	6.7	1,227	541	5.9
	1000	1,511	699	7.7	1,438	626	6.9
	1200	1,769	785	8.6	1,686	711	7.8
15		Ht 32.2 ft			Ht 31.7 ft		
	800	1,457	797	8.8	1,400	735	8.1
	1000	1,701	887	9.7	1,637	823	9.0
	1200	1,986	976	10.7	1,913	912	10.0
ANNUAL RAINFALL = 56 inches							
5		Ht 42.9 ft			Ht 42.3 ft		
	600	2,428	2,060	22.6	2,364	1,986	21.8
	800	2,793	2,168	23.8	2,721	2,093	23.0
	1000	3,214	2,276	25.0	3,133	2,200	24.2
	1200	3,698	2,384	26.2	3,607	2,307	25.4
10		Ht 44.4 ft			Ht 43.7 ft		
	600	2,580	2,244	24.7	2,510	2,159	23.7
	800	2,964	2,354	25.9	2,886	2,268	24.9
	1000	3,406	2,464	27.1	3,318	2,377	26.1
	1200	3,913	2,574	28.3	3,815	2,486	27.3
15		Ht 46.0 ft			Ht 45.4 ft		
	600	2,729	2,437	26.8	2,675	2,365	26.0
	800	3,131	2,548	28.0	3,071	2,476	27.2
	1000	3,592	2,660	29.2	3,525	2,587	28.4
	1200	4,121	2,772	30.5	4,046	2,698	29.6

LONGLEAF PINE
WET SITES
GROWING SEASON RAINFALL = 28 inches

Texture of 16-20" layer		Trees	0 Percent Slope			1 Percent Slope			3 Percent Slope		
Sand	Clay	/A	Total	Merchantable		Total	Merchantable		Total	Merchantable	
--*Percent*--		-*No.*-	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*
65	10		Ht 18.4 ft			Ht 22.3 ft			Ht 22.5 ft		
		300	240	...	...	367	...	...	374	...	...
		500	324	...	...	493	...	...	502	...	...
40	20		Ht 25.6 ft			Ht 29.4 ft			Ht 29.7 ft		
		300	481	116	1.3	620	303	3.3	632	318	3.5
		500	644	152	1.7	828	398	4.4	843	418	4.6
		700	862	188	2.1	1,106	494	5.4	1,125	518	5.7
		900	...	...	...	1,476	590	6.5	1,502	617	6.8
30	35		Ht 25.8 ft			Ht 29.7 ft			Ht 29.9 ft		
		300	488	125	1.4	632	318	3.5	640	329	3.6
		500	654	165	1.8	843	418	4.6	853	431	4.7
		700	875	204	2.2	1,125	518	5.7	1,139	533	5.9
		900	...	...	...	1,502	617	6.8	1,519	636	7.0
20	15		Ht 28.8 ft			Ht 32.6 ft			Ht 32.9 ft		
		300	598	272	3.0	745	473	5.2	758	490	5.4
		500	798	359	3.9	993	608	6.7	1,009	628	6.9
		700	1,066	446	4.9	1,324	743	8.2	1,345	766	8.4
		900	1,424	534	5.9	1,764	878	9.6	1,791	905	9.9
		1100	...	...	...	2,350	1,013	11.1	2,387	1,043	11.5
	35		Ht 26.7 ft			Ht 30.5 ft			Ht 30.8 ft		
		300	521	168	1.8	663	360	4.0	674	376	4.1
		500	696	223	2.4	884	470	5.2	899	490	5.4
		700	931	278	3.1	1,179	580	6.4	1,199	604	6.6
		900	...	...	...	1,573	690	7.6	1,599	718	7.9
	50		Ht 21.0 ft			Ht 24.9 ft			Ht 25.1 ft		
		300	324	...	...	457	84	0.9	464	93	1.0
		500	435	...	...	611	107	1.2	621	120	1.3
		700	...	...	...	819	130	1.4	831	146	1.6

LONGLEAF PINE
WET SITES
GROWING SEASON RAINFALL = 38 inches

Texture of 16-20" layer		Trees	0 Percent Slope			1 Percent Slope			3 Percent Slope		
Sand	Clay	/A	Total	Merchantable		Total	Merchantable		Total	Merchantab	
--*Percent*--		-*No.*-	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cor*
65	10		Ht 14.8 ft			Ht 18.6 ft			Ht 18.9 ft		
		300	136	...	...	247	...	...	256	...	...
		500	...	...	...	333	...	...	345	...	...
40	20		Ht 21.9 ft			Ht 25.8 ft			Ht 26.0 ft		
		300	354	...	...	488	125	1.4	496	134	1.5
		500	475	...	...	654	165	1.8	663	177	2.0
		700	...	...	...	875	204	2.2	887	221	2.4
30	35		Ht 22.2 ft			Ht 26.0 ft			Ht 26.3 ft		
		300	364	...	...	496	134	1.5	506	149	1.6
		500	488	...	...	663	178	2.0	677	197	2.2
		700	...	...	...	887	221	2.4	906	245	2.7
20	15		Ht 25.1 ft			Ht 29.0 ft			Ht 29.2 ft		
		300	464	93	1.0	605	282	3.1	613	292	3.2
		500	621	119	1.3	808	372	4.1	818	385	4.2
		700	831	146	1.6	1,079	462	5.1	1,092	478	5.3
		900	...	...	...	1,441	552	6.1	1,458	571	6.3
	35		Ht 23.0 ft			Ht 26.9 ft			Ht 27.1 ft		
		300	391	1	0.0	528	177	1.9	535	187	2.1
		500	524	-15	-0.2	706	236	2.6	715	249	2.7
		700	703	-31	-0.3	944	294	3.2	956	310	3.4
	50		Ht 17.4 ft			Ht 21.2 ft			Ht 21.5 ft		
		300	210	...	...	330	...	...	340	...	...
		500	...	...	...	444	...	...	457	...	...

LONGLEAF PINE
INTERMEDIATE SITES
GROWING SEASON RAINFALL = 28 inches
ORGANIC MATTER = 0.5 percent

Thickness of A horizon	Trees /A	1 Percent Slope			3 Percent Slope			5 Percent Slope			7 Percent Slope		
		Total	Merchantable		Total	Merchantable		Total	Merchantable		Total	Merchantable	
---*Inches*---	-*No.*-	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*
5		Ht 38.6 ft			Ht 36.0 ft			Ht 33.4 ft			Ht 30.9 ft		
	300	1,007	815	9.0	889	664	7.3	778	517	5.7	678	381	4.2
	500	1,339	1,006	11.1	1,182	833	9.2	1,036	661	7.3	904	496	5.5
	700	1,779	1,198	13.2	1,573	1,002	11.0	1,380	805	8.8	1,206	612	6.7
	900	2,365	1,389	15.3	2,092	1,171	12.9	1,838	948	10.4	1,608	727	8.0
	1100	3,143	1,580	17.4	2,784	1,341	14.7	2,449	1,092	12.0	...	...	...
10		Ht 41.7 ft			Ht 39.1 ft			Ht 36.5 ft			Ht 34.0 ft		
	300	1,162	1,000	11.0	1,031	845	9.3	911	693	7.6	803	551	6.1
	500	1,542	1,214	13.3	1,370	1,040	11.4	1,211	866	9.5	1,069	700	7.7
	700	2,048	1,428	15.7	1,821	1,235	13.6	1,611	1,040	11.4	1,424	850	9.3
	900	2,719	1,642	18.0	2,419	1,430	15.7	2,143	1,214	13.3	1,896	1,000	11.0
	1100	3,610	1,856	20.4	3,215	1,625	17.9	2,851	1,387	15.2	2,524	1,150	12.6
15		Ht ...			Ht 42.2 ft			Ht 39.7 ft			Ht 37.1 ft		
	300	...	...	...	1,188	1,031	11.3	1,060	880	9.7	938	727	8.0
	500	...	...	...	1,577	1,248	13.7	1,409	1,080	11.9	1,247	906	10.0
	700	...	...	...	2,094	1,465	16.1	1,871	1,280	14.1	1,658	1,085	11.9
	900	...	...	...	2,780	1,682	18.5	2,486	1,479	16.3	2,205	1,264	13.9
	1100	...	...	...	3,690	1,900	20.9	3,303	1,679	18.4	2,932	1,443	15.9
20		Ht ...			Ht 45.3 ft			Ht ...			Ht ...		
	500	...	...	...	1,809	1,458	16.0	...	...	...	...	...	...
	700	...	...	...	2,400	1,694	18.6	...	...	...	...	...	...
	900	...	...	...	3,183	1,930	21.2	...	...	...	...	...	...
	1100	...	...	...	4,222	2,167	23.8	...	...	...	...	...	...

LONGLEAF PINE
INTERMEDIATE SITES
GROWING SEASON RAINFALL = 28 inches
ORGANIC MATTER = 1.5 percent

Thickness of A horizon	Trees /A	1 Percent Slope			3 Percent Slope			5 Percent Slope			7 Percent Slope		
		Total	Merchantable		Total	Merchantable		Total	Merchantable		Total	Merchantable	
---*Inches*---	-*No.*-	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*
5		Ht 34.2 ft			Ht 31.7 ft			Ht 29.1 ft			Ht 26.6 ft		
	300	811	562	6.2	709	424	4.7	609	287	3.2	517	163	1.8
	500	1,080	714	7.8	946	549	6.0	813	379	4.2	691	216	2.4
	700	1,438	866	9.5	1,261	674	7.4	1,086	470	5.2	925	270	3.0
	900	1,915	1,018	11.2	1,681	798	8.8	1,450	562	6.2	...	...	...
	1100	2,549	1,170	12.9	...	...	...	...	...	...	...	...	...
10		Ht 37.4 ft			Ht 34.8 ft			Ht 32.2 ft			Ht 29.7 ft		
	300	951	745	8.2	837	596	6.5	729	451	5.0	632	318	3.5
	500	1,265	926	10.2	1,114	753	8.3	972	582	6.4	843	418	4.6
	700	1,682	1,108	12.2	1,482	911	10.0	1,295	712	7.8	1,125	518	5.7
	900	2,236	1,289	14.2	1,973	1,069	11.7	1,727	843	9.3	1,502	617	6.8
	1100	2,974	1,470	16.2	2,626	1,227	13.5	...	...	...	...	...	...
15		Ht ...			Ht 37.9 ft			Ht 35.3 ft			Ht 32.8 ft		
	300	...	...	...	974	774	8.5	858	624	6.9	754	484	5.3
	500	...	...	...	1,295	960	10.5	1,142	787	8.6	1,004	621	6.8
	700	...	...	...	1,722	1,145	12.6	1,520	949	10.4	1,338	759	8.3
	900	...	...	...	2,289	1,331	14.6	2,022	1,112	12.2	1,782	896	9.8
	1100	...	...	...	3,043	1,516	16.7	2,691	1,275	14.0	2,374	1,033	11.4
20		Ht ...			Ht 41.0 ft			Ht ...			Ht ...		
	300	...	...	...	1,125	958	10.5	...	...	...	...	...	...
	500	...	...	...	1,495	1,167	12.8	...	...	...	...	...	...
	700	...	...	...	1,985	1,376	15.1	...	...	...	...	...	...
	900	...	...	...	2,636	1,585	17.4	...	...	...	...	...	...
	1100	...	...	...	3,500	1,794	19.7	...	...	...	...	...	...

LONGLEAF PINE
INTERMEDIATE SITES
GROWING SEASON RAINFALL = 28 inches
ORGANIC MATTER = 2.5 percent

Thickness of A horizon	Trees /A	1 Percent Slope			3 Percent Slope			5 Percent Slope			7 Percent Slope		
		Total	Merchantable		Total	Merchantable		Total	Merchantable		Total	Merchantable	
---*Inches*---	-*No.*-	-Ft^3-	-Ft^3-	*Cords*	-Ft^3-	-Ft^3-	*Cords*	-Ft^3-	-Ft^3-	*Cords*	-Ft^3-	-Ft^3-	*Cords*
5		Ht 31.9 ft			Ht 29.4 ft			Ht 26.8 ft			Ht 24.3 ft		
	300	717	435	4.8	620	303	3.3	524	173	1.9	436	57	0.6
	500	956	562	6.2	828	398	4.4	701	229	2.5	584	68	0.7
	700	1,275	689	7.6	1,106	494	5.4	937	286	3.1	782	80	0.9
	900	1,699	816	9.0	1,476	590	6.5	...	...	...	...	...	...
10		Ht 35.1 ft			Ht 32.5 ft			Ht 29.9 ft			Ht 27.4 ft		
	300	849	613	6.7	741	468	5.1	640	329	3.6	546	202	2.2
	500	1,131	773	8.5	988	602	6.6	853	431	4.7	730	268	2.9
	700	1,505	934	10.3	1,316	735	8.1	1,139	533	5.9	976	335	3.7
	900	2,003	1,095	12.0	1,754	869	9.6	1,519	636	7.0	...	...	...
	1100	2,665	1,256	13.8	...	...	...	...	...	...	...	...	...
15		Ht ...			Ht 35.6 ft			Ht 33.0 ft			Ht 30.5 ft		
	300	...	...	...	871	641	7.0	762	495	5.4	663	360	4.0
	500	...	...	...	1,159	807	8.9	1,015	635	7.0	884	470	5.2
	700	...	...	...	1,542	972	10.7	1,352	774	8.5	1,179	580	6.4
	900	...	...	...	2,052	1,137	12.5	1,801	913	10.0	1,573	690	7.6
	1100	...	...	...	2,731	1,303	14.3	2,399	1,053	11.6	...	...	...
20		Ht ...			Ht 38.7 ft			Ht ...			Ht ...		
	300	...	...	...	1,012	821	9.0	...	...	...	...	...	...
	500	...	...	...	1,345	1,013	11.1	...	...	...	...	...	...
	700	...	...	...	1,787	1,205	13.2	...	...	...	...	...	...
	900	...	...	...	2,375	1,397	15.4	...	...	...	...	...	...
	1100	...	...	...	3,157	1,589	17.5	...	...	...	...	...	...

LONGLEAF PINE
INTERMEDIATE SITES
GROWING SEASON RAINFALL = 38 inches
ORGANIC MATTER = 0.5 percent

Thickness of A horizon	Trees /A	1 Percent Slope			3 Percent Slope			5 Percent Slope			7 Percent Slope		
		Total	Merchantable		Total	Merchantable		Total	Merchantable		Total	Merchantable	
---*Inches*---	-*No.*-	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*
5		Ht 33.0 ft			Ht 30.4 ft			Ht 27.9 ft			Ht 25.3 ft		
	300	762	495	5.4	659	355	3.9	564	227	2.5	471	102	1.1
	500	1,015	634	7.0	879	464	5.1	754	301	3.3	630	132	1.5
	700	1,352	774	8.5	1,172	573	6.3	1,008	375	4.1	843	163	1.8
	900	1,801	913	10.0	1,564	681	7.5	1,346	449	4.9	...	...	...
	1100	2,399	1,053	11.6	...	...	...	...	...	...	...	...	...
10		Ht 36.1 ft			Ht 33.5 ft			Ht 31.0 ft			Ht 28.4 ft		
	300	893	670	7.4	782	523	5.7	682	387	4.2	583	252	2.8
	500	1,188	840	9.2	1,042	668	7.3	909	503	5.5	779	333	3.7
	700	1,580	1,010	11.1	1,387	812	8.9	1,213	619	6.8	1,040	415	4.6
	900	2,102	1,180	13.0	1,848	957	10.5	1,617	736	8.1	1,389	496	5.5
	1100	2,797	1,350	14.8	2,461	1,102	12.1	...	...	...	...	...	...
15		Ht ...			Ht 36.7 ft			Ht 34.1 ft			Ht 31.5 ft		
	300	...	...	...	920	704	7.7	807	556	6.1	702	413	4.5
	500	...	...	...	1,223	880	9.7	1,075	707	7.8	935	536	5.9
	700	...	...	...	1,627	1,055	11.6	1,431	858	9.4	1,247	658	7.2
	900	...	...	...	2,164	1,230	13.5	1,905	1,009	11.1	1,663	781	8.6
	1100	...	...	...	2,878	1,406	15.4	2,537	1,160	12.7	...	...	...
20		Ht ...			Ht 39.8 ft			Ht ...			Ht ...		
	300	...	...	...	1,065	886	9.7	...	...	...	...	...	...
	500	...	...	...	1,415	1,087	11.9	...	...	...	...	...	...
	700	...	...	...	1,880	1,287	14.1	...	...	...	...	...	...
	900	...	...	...	2,498	1,488	16.3	...	...	...	...	...	...
	1100	...	...	...	3,318	1,688	18.5	...	...	...	...	...	...

LONGLEAF PINE
INTERMEDIATE SITES
GROWING SEASON RAINFALL = 38 inches
ORGANIC MATTER = 1.5 percent

Thickness of A horizon	Trees /A	1 Percent Slope			3 Percent Slope			5 Percent Slope			7 Percent Slope		
		Total	Merchantable		Total	Merchantable		Total	Merchantable		Total	Merchantable	
---*Inches*---	-*No.*-	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*
5		Ht 28.7 ft			Ht 26.1 ft			Ht 23.6 ft			Ht 21.0 ft		
	300	594	267	2.9	499	139	1.5	411	26	0.3	324	...	...
	500	793	353	3.9	668	184	2.0	551	23	0.3	435	...	...
	700	1,060	439	4.8	893	229	2.5	739	20	0.2	...	...	...
	900	1,415	524	5.8	...	...	...	...	...	...	...	...	...
10		Ht 31.8 ft			Ht 29.2 ft			Ht 26.7 ft			Ht 24.1 ft		
	300	713	430	4.7	613	292	3.2	521	168	1.8	429	48	0.5
	500	951	556	6.1	818	385	4.2	696	223	2.4	574	55	0.6
	700	1,268	681	7.5	1,092	478	5.3	931	278	3.1	770	63	0.7
	900	1,690	807	8.9	1,458	571	6.3	...	...	...	...	...	...
15		Ht ...			Ht 32.3 ft			Ht 29.8 ft			Ht 27.2 ft		
	300	...	...	...	733	457	5.0	636	323	3.6	539	192	2.1
	500	...	...	...	977	588	6.5	848	424	4.7	720	255	2.8
	700	....	...	...	1,302	720	7.9	1,132	525	5.8	963	318	3.5
	900	...	...	...	1,736	852	9.4	1,511	626	6.9	...	...	...
20		Ht ...			Ht 35.5 ft			Ht ...			Ht ...		
	300	...	...	...	867	635	7.0	...	...	...	...	...	...
	500	...	...	...	1,153	800	8.8	...	...	...	...	...	...
	700	...	...	...	1,535	964	10.6	...	...	...	...	...	...
	900	...	...	...	2,042	1,129	12.4	...	...	...	...	...	...
	1100	...	...	...	2,717	1,294	14.2	...	...	...	...	...	...

LONGLEAF PINE
INTERMEDIATE SITES
GROWING SEASON RAINFALL = 38 inches
ORGANIC MATTER = 2.5 percent

Thickness of A horizon	Trees /A	1 Percent Slope			3 Percent Slope			5 Percent Slope			7 Percent Slope		
		Total	Merchantable		Total	Merchantable		Total	Merchantable		Total	Merchantable	
---*Inches*---	-*No.*-	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*
5		Ht 26.4 ft			Ht 23.8 ft			Ht 21.3 ft			Ht 18.7 ft		
	300	510	153	1.7	418	35	0.4	334	...	...	250	...	...
	500	682	203	2.2	561	36	0.4	448	...	...	337	...	...
	700	912	253	2.8	751	37	0.4	...	...	...	...	...	...
10		Ht 29.5 ft			Ht 26.9 ft			Ht 24.4 ft			Ht 21.8 ft		
	300	624	308	3.4	528	177	1.9	439	61	0.7	350	...	...
	500	833	405	4.4	706	236	2.5	588	75	0.8	470	...	...
	700	1,122	502	5.5	944	294	3.2	788	88	1.0	...	...	...
	900	1,484	599	6.6	...	...	...	...	...	...	...	...	...
15		Ht ...			Ht 30.0 ft			Ht 27.5 ft			Ht 24.9 ft		
	300	...	...	...	643	334	3.7	550	207	2.3	457	83	0.9
	500	...	...	...	858	438	4.8	735	275	3.0	611	107	1.2
	700	...	...	...	1,145	541	5.9	982	343	3.8	819	130	1.4
	900	...	...	...	1,528	645	7.1	...	...	...	...	...	...
20		Ht ...			Ht 33.2 ft			Ht ...			Ht ...		
	300	...	...	...	770	506	5.6	...	...	...	...	...	...
	500	...	...	...	1,025	648	7.1	...	...	...	...	...	...
	700	...	...	...	1,366	789	8.7	...	...	...	...	...	...
	900	...	...	...	1,820	931	10.2	...	...	...	...	...	...
	1100	...	...	...	2,424	1,072	11.8	...	...	...	...	...	...

LONGLEAF PINE
DRY SITES
GROWING SEASON RAINFALL = 24 inches

Silt in 6-10" layer	Texture of 36-42" layer		Trees /A	2 Percent Slope			4 Percent Slope		
	Silt	Clay		Total	Merchantable		Total	Merchantable	
--*Percent*--	---*Percent*--		-*No.*-	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*
5	5	3		Ht 30.6 ft			Ht 33.1 ft		
			300	666	365	4.0	766	501	5.5
			500	889	477	5.2	1,020	641	7.0
			700	1,186	588	6.5	1,359	782	8.6
			900	1,582	699	7.7	1,810	922	10.1
			1100	...	...	...	2,411	1,062	11.7
	10	6		Ht 40.4 ft			Ht 42.9 ft		
			300	1,095	922	10.1	...	...	...
			500	1,454	1,127	12.4	1,627	1,295	14.2
			700	1,932	1,332	14.6	2,160	1,517	16.7
			900	2,566	1,537	16.9	2,867	1,739	19.1
			1100	3,408	1,741	19.1	3,805	1,961	21.5
10	10	6		Ht 31.6 ft			Ht 34.1 ft		
			300	706	419	4.6	807	556	6.1
			500	941	542	6.0	1,075	707	7.8
			700	1,254	666	7.3	1,431	858	9.4
			900	1,672	789	8.7	1,905	1,009	11.1
			1100	...	...	...	2,537	1,160	21.7

LONGLEAF PINE
DRY SITES
GROWING SEASON RAINFALL = 27 inches

Silt in 6-10" layer	Texture of 36-42" layer		Trees /A	2 Percent Slope			4 Percent Slope		
	Silt	Clay		Total	Merchantable		Total	Merchantable	
--Percent--	*---Percent--*		*-No.-*	*-Ft^3-*	*-Ft^3-*	*Cords*	*-Ft^3-*	*-Ft^3-*	*Cords*
5	5	3		Ht 36.5 ft			Ht 39.0 ft		
			300	911	693	7.6	1,026	839	9.2
			500	1,211	866	9.5	1,364	1,033	11.4
			700	1,611	1,040	11.4	1,812	1,227	13.5
			900	2,143	1,214	13.3	2,408	1,422	15.6
			1100	2,851	1,387	15.2	3,200	1,616	17.8
	10	6		Ht 46.3 ft			Ht 48.8 ft		
			500	1,890	1,525	16.8	...	...	...
			700	2,506	1,767	19.4	2,793	1,951	21.4
			900	3,323	2,009	22.1	...	...	...
			1100	4,407	2,251	24.7	...	...	...
10	10	6		Ht 37.5 ft			Ht 40.0 ft		
			300	956	751	8.2	1,075	898	9.9
			500	1,271	933	10.3	1,428	1,100	12.1
			700	1,690	1,115	12.3	1,897	1,302	14.3
			900	2,247	1,297	14.3	2,520	1,504	16.5
			1100	2,987	1,480	16.3	3,348	1,706	18.7

SHORTLEAF PINE
INTERMEDIATE SITES
GROWING SEASON RAINFALL = 28 inches
SAND IN A2 HORIZON = 85 percent

Sand in B2 horizon	Trees /A	1 Percent Slope			3 Percent Slope			5 Percent Slope			7 Percent Slope		
		Total	Merchantable		Total	Merchantable		Total	Merchantable		Total	Merchantable	
--*Percent*-	-*No.*-	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*
75		Ht 29.4 ft			Ht 35.6 ft			Ht 32.4 ft			Ht 29.8 ft		
	800	...	...	...	2,142	1,459	16.0	...	...	...	...	...	...
	1000	1,523	709	7.8	2,441	1,472	16.2	1,950	1,056	11.6	1,578	753	8.3
	1200	1,921	761	8.4	2,781	1,485	16.3	2,330	1,087	11.9	1,974	802	8.8
55		Ht 29.7 ft			Ht 35.9 ft			Ht 32.7 ft			Ht 30.1 ft		
	800	...	...	...	2,192	1,502	16.5	1,677	1,063	11.7	...	...	...
	1000	1,564	742	8.2	2,488	1,513	16.6	1,995	1,093	12.0	1,619	786	8.6
	1200	1,961	792	8.7	2,824	1,525	16.8	2,372	1,122	12.3	2,014	833	9.2
35		Ht 27.1 ft			Ht 33.3 ft			Ht 30.1 ft			Ht 27.5 ft		
	800	...	...	...	1,770	1,142	12.6	...	...	...	...	...	...
	1000	1,230	473	5.2	2,085	1,168	12.8	1,619	786	8.6	1,279	513	5.6
	1200	1,630	544	6.0	2,457	1,193	13.1	2,014	833	9.2	1,679	580	6.4
15		Ht 21.5 ft			Ht 27.7 ft			Ht 24.5 ft			Ht 21.9 ft		
	1000	663	...	...	1,303	532	5.8	940	238	2.6	696	...	...
	1200	1,036	...	...	1,704	598	6.6	1,332	335	3.7	1,072	...	...

SHORTLEAF PINE
INTERMEDIATE SITES
GROWING SEASON RAINFALL = 28 inches
SAND IN A2 HORIZON = 65 percent

Sand in B2 horizon	Trees /A	1 Percent Slope			3 Percent Slope			5 Percent Slope			7 Percent Slope		
		Total	Merchantable		Total	Merchantable		Total	Merchantable		Total	Merchantable	
--*Percent*-	-*No.*-	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*
55		Ht 34.3 ft			Ht 40.6 ft			Ht 37.4 ft			Ht 34.8 ft		
	800	1,929	1,277	14.0	2,988	2,228	24.5	2,445	1,723	18.9	2,010	1,346	14.8
	1000	2,238	1,297	14.3	3,210	2,218	24.4	2,723	1,727	19.0	2,316	1,363	15.0
	1200	2,598	1,317	14.5	3,448	2,208	24.3	3,032	1,731	19.0	2,669	1,381	15.2
35		Ht 31.7 ft			Ht 37.9 ft			Ht 34.7 ft			Ht 32.1 ft		
	800	...	...	...	2,530	1,799	19.8	1,993	1,332	14.6	...	...	...
	1000	1,847	971	10.7	2,800	1,801	19.8	2,300	1,350	14.8	1,905	1,019	11.2
	1200	2,233	1,007	11.1	3,100	1,802	19.8	2,654	1,368	15.0	2,288	1,052	11.6
15		Ht 26.1 ft			Ht 32.4 ft			Ht 29.2 ft			Ht 26.6 ft		
	1000	1,113	379	4.2	1,950	1,056	11.6	1,497	688	7.6	1,171	426	4.7
	1200	1,511	459	5.0	2,330	1,087	11.9	1,895	741	8.1	1,570	501	5.5

SHORTLEAF PINE
INTERMEDIATE SITES
GROWING SEASON RAINFALL = 28 inches
SAND IN A2 HORIZON = 40 percent

Sand in	Trees	1 Percent Slope			3 Percent Slope			5 Percent Slope			7 Percent Slope		
B2 horizon	/A	Total	Merchantable		Total	Merchantable		Total	Merchantable		Total	Merchantable	
--*Percent*-	-*No.*-	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*
35		Ht 33.2 ft			Ht 39.4 ft			Ht 36.2 ft			Ht 33.6 ft		
	800	1,754	1,129	12.4	2,786	2,033	22.3	2,242	1,545	17.0	1,817	1,182	13.0
	1000	2,070	1,115	12.7	3,031	2,028	22.3	2,535	1,555	17.1	2,131	1,206	13.3
	1200	2,442	1,181	13.0	3,298	2,024	22.2	2,866	1,565	17.2	2,499	1,230	13.5
15		Ht 27.6 ft			Ht 33.8 ft			Ht 30.6 ft			Ht 28.1 ft		
	800	...	...	...	1,849	1,209	13.3	...	...	...	...	...	...
	1000	1,291	522	5.7	2,161	1,232	13.5	1,689	843	9.3	1,354	573	6.3
	1200	1,691	589	6.5	2,527	1,255	13.8	2,082	886	9.7	1,754	635	7.0
SAND IN A2 HORIZON = 20 percent													
15		Ht 25.3 ft			Ht 31.5 ft			Ht 28.3 ft			Ht 25.7 ft		
	1000	1,024	307	3.4	1,817	947	10.4	1,379	593	6.5	1,068	343	3.8
	1200	1,420	395	4.3	2,205	984	10.8	1,779	654	7.2	1,465	426	4.7

SHORTLEAF PINE
INTERMEDIATE SITES
GROWING SEASON RAINFALL = 38 inches
SAND IN A2 HORIZON = 85 percent

Sand in B2 horizon	Trees /A	1 Percent Slope			3 Percent Slope			5 Percent Slope			7 Percent Slope		
		Total	Merchantable		Total	Merchantable		Total	Merchantable		Total	Merchantable	
--*Percent*-	-*No.*-	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*
75		Ht 18.8 ft			Ht 25.0 ft			Ht 21.8 ft			Ht 19.2 ft		
	1000	465	...	...	992	281	3.1	688	...	...	492	...	...
	1200	815	...	...	1,386	372	4.1	1,063	...	...	845	...	...
55		Ht 19.1 ft			Ht 25.3 ft			Ht 22.1 ft			Ht 19.5 ft		
	1000	485	...	...	1,024	307	3.4	713	...	...	512	...	...
	1200	837	...	...	1,420	395	4.3	1,091	...	...	868	...	...
35		Ht 16.4 ft			Ht 22.7 ft			Ht 19.5 ft			Ht 16.9 ft		
	1000	328	...	...	766	96	1.1	512	...	...	354	...	...
	1200	655	...	...	1,148	213	2.3	868	...	...	686	...	...
15		Ht 10.9 ft			Ht 17.1 ft			Ht 13.9 ft			Ht 11.3 ft		
	1000	...	...	...	364	...	...	217	...	...	...	...	...
	1200	...	...	...	698	...	...	524	...	...	...	...	...

SHORTLEAF PINE
INTERMEDIATE SITES
GROWING SEASON RAINFALL = 38 inches
SAND IN A2 HORIZON = 65 percent

Sand in B2 horizon	Trees /A	1 Percent Slope			3 Percent Slope			5 Percent Slope			7 Percent Slope		
		Total	Merchantable		Total	Merchantable		Total	Merchantable		Total	Merchantable	
--Percent-	*-No.-*	-Ft^3-	-Ft^3-	*Cords*	-Ft^3-	-Ft^3-	*Cords*	-Ft^3-	-Ft^3-	*Cords*	-Ft^3-	-Ft^3-	*Cords*
55		Ht 23.7 ft			Ht 29.9 ft			Ht 26.7 ft			Ht 24.2 ft		
	1000	860	173	1.9	1,591	764	8.4	1,183	435	4.8	910	213	2.3
	1200	1,248	278	3.1	1,988	812	8.9	1,582	509	5.6	1,300	313	3.4
35		Ht 21.1 ft			Ht 27.3 ft			Ht 24.1 ft			Ht 21.5 ft		
	1000	631	...	...	1,254	493	5.4	899	205	2.3	663	...	...
	1200	1,000	123	1.4	1,654	562	6.2	1,289	306	3.4	1,036	144	1.6
15		Ht 15.5 ft			Ht 21.7 ft			Ht 18.5 ft			Ht 16.0 ft		
	1000	284	...	...	680	...	...	446	...	...	308	...	...
	1200	604	...	...	1,054	...	...	793	...	...	632	...	...
SAND IN A2 HORIZON = 40 percent													
35		Ht 22.6 ft			Ht 23.8 ft			Ht 25.6 ft			Ht 23.0 ft		
	1000	757	88	1.0	870	181	2.0	1,057	334	3.7	794	118	1.3
	1200	1,138	207	2.3	1,258	285	3.1	1,454	418	4.6	1,117	232	2.6
15		Ht 17.0 ft			Ht 23.2 ft			Ht 20.0 ft			Ht 17.4 ft		
	1000	359	...	...	812	134	1.5	547	...	...	381	...	...
	1200	692	...	...	1,197	245	2.7	908	...	...	718	...	...

SHORTLEAF PINE
INTERMEDIATE SITES
GROWING SEASON RAINFALL = 38 inches
SAND IN A2 HORIZON = 20 percent

Sand in B2 horizon	Trees /A	1 Percent Slope			3 Percent Slope			5 Percent Slope			7 Percent Slope		
		Total	Merchantable		Total	Merchantable		Total	Merchantable		Total	Merchantable	
--*Percent*-	-*No.*-	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*
15		Ht 14.7 ft			Ht 20.9 ft			Ht 17.7 ft			Ht 15.1 ft		
	1000	249	...	...	615	...	...	398	...	...	266	...	...
	1200	562	...	...	983	...	...	738	...	...	582	...	...

SHORTLEAF PINE
DRY SITES

Clay in 16-20" layer	Trees /A	2 Percent		
		Total	Merchantable	
---*Percent*--	-*No.*-	-*Ft*^{3}-	-*Ft*^{3}-	*Cords*
3		Ht 24.4 ft		
	1000	930	230	2.5
	1200	1,321	327	3.6
6		Ht 30.2 ft		
	1000	1,633	797	8.8
	1200	2,028	843	9.3
15		Ht 44.8 ft		
	800	3,648	2,958	32.5
	1000	3,766	2,934	32.2
	1200	3,889	2,909	32.0

Conversion to Metric Units

Centimeters = Inches × 2.54
Meters = Feet × 0.3048
Cubic meters = Cubic feet × 0.0283168
Cubic meters (stacked) = Cords × 3.62456
Cubic meters per hectare = Cubic feet per acre × .0699725
Cubic meters (stacked) per hectare = Cords per acre × 8.95647
Trees per hectare = Trees per acre × 0.404686

SHOULDERS, EUGENE, AND FRANCES V. WALKER.

1979. Soil, slope, and rainfall affect height and yield in 15-year-old southern pine plantations. U.S. Dep. Agric. For. Serv. Res. Pap. SO-153, 52 p. South. For. Exp. Stn. New Orleans, La.

Presents equations for predicting heights at age 15 of dominant and codominant loblolly, slash, longleaf, and shortleaf pine from characteristics of the planting site. Also included are tables that contain solutions of these equations for many site characteristics and tree densities.

Additional keywords: *Pinus echinata, Pinus elliottii, Pinus taeda, Pinus palustris*, growth and yield, soil-site relationships, soil-yield relationships.

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Growth and Yield Estimation for Loblolly Pine in the West Gulf

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Southern Forest Experiment Station

SUMMARY

An equation system is developed to estimate current yield, projected basal area, and projected volume for merchantable natural stands on a per-acre basis. These estimates indicate yields that can be expected from woods-run conditions.

1979

Growth and Yield Estimation for Loblolly Pine in the West Gulf

PAUL A. MURPHY
AND
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INTRODUCTION

Loblolly (*Pinus taeda* L.) is the keystone of the southern pine forest products industry. Except in Florida, where slash pine (P. *elliottii* Engelm.) prevails, it dominates in the Atlantic and Gulf coastal States south of New Jersey, accounting for nearly half the total southern pine inventory. About a third of the loblolly resource is west of the Mississippi River (Sternitzke and Nelson 1970).

According to the most recent State-by-State field inventories conducted by the Forest Service as part of the nationwide Forest Survey, standing volume of southern pine on commercial forest land[1] west of the Mississippi is more than 22 billion cubic feet (table 1); nearly 13 billion is loblolly pine (table 2).

Table 1.— *Volume by state of southern pine growing stock on commercial forest land west of the Mississippi River*

State	Date of Survey	Growing Stock
		Million cubic feet
Arkansas	1969	6,192.2
Louisiana[1]	1974	6,779.4
Missouri	1972	305.0
Oklahoma	1976	1,002.4
Texas	1975	8,075.2
All States		22,354.2

[1]Excludes southeast Louisiana parishes.

West of the Mississippi Valley, loblolly pine is restricted to the Coastal Plain in Arkansas, Louisiana, southeast Oklahoma, and east Texas. The main factor limiting the northern extension of its natural range probably is temperature. Also, damage by snow and sleet may be a factor. The western extension of loblolly probably is limited by lack of precipitation (USDA Forest Service 1965).

Information on growth and yield of natural stands of loblolly pine in the West Gulf Coastal Plain is deficient. Older studies do not provide information on stands not fully or normally stocked. More recent studies were conducted in other regions of the South and sampled pure, uniformly stocked stands, but stands encountered in practice do not approach the pure, ideal conditions sampled in these studies. Many are not uniformly stocked, most have a significant hardwood component, and their yields are less.

The growth and yield relationships represented here have been observed on inventory plots throughout the West Gulf. Inventory data have more unexplained variation than do data from controlled studies, and variables tend to be clustered rather than dispersed throughout their range of possible values. This type of information, however, has the advantage of depicting actual conditions.

Data

The data are from remeasured plots of statewide surveys made by the Forest Service. The interval between surveys is about 10 years. Sample plots are at the intersections of a 3-mile-square grid. Information was collected according

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[1]Forest land either producing or capable of producing crops of industrial wood and not withdrawn from timber utilization.

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to standardized inventory procedures.[2] Plots have 10-point samples spaced 66 feet apart over about 1 acre.

Plots within the Coastal Plain of the West Gulf region were screened by use of these criteria: (1) at least half the basal area in trees 5 inches and larger in the initial survey had to be loblolly pine; (2) all 10 points at each location had to be recovered in the remeasurement tally; (3) site quality information had to be collected from loblolly pine sample trees; (4) plots had to be free from catastrophic mortality, (5) sampled stands had to be even-aged and natural in origin and (6) plots had to be undisturbed by logging or other activity between measurements. Dates of surveys are Louisiana, 1964 and 1974; east Texas, 1965 and 1975; and Arkansas,[3] 1969 and 1978.

The geographical distribution of 145 sample plots that met these criteria is shown in figure 1. Numbers of plots by age, site, and density are tabulated in table 3. Average stand age is 38; average basal area, 70 square feet per acre; and average site index, 90 feet. The range of data is from 17 to 137 square feet of basal area at remeasurement; site index varies from 68 to 127 feet; and stand age ranges from 18 to 85 years at remeasurement.

These stand and tree statistics were calculated: (1) site index from equations developed by Farrar (1973); (2) stand age at first measurement and at remeasurement; (3) basal area in square feet per acre of loblolly pine trees 5 inches and larger at the first measurement and of the same trees at remeasurement; and (4) s wood volume from a 1-foot stump to a 4-inch outside bark, of trees included in the basal a calculations. The data were then summari into plot statistics according to Beers and Mi (1964).

Estimation in Equation Systems

Much recent research in the growth and yi of even-aged natural timber stands has used d from remeasured permanent plots. This infor tion has prompted interest in estimating not o current volumes but also future yields. So variables used to predict stand volume, such site quality, are assumed to be constant. Othe such as stand age, change by a known amou Others, such as basal area, change by an unkno amount, and their future values must be timated. The result is an interdependent set prediction equations.

Clutter (1963) fitted a yield model, a ba area growth model, and a volume growth mo by least squares. He derived basal area projecti and volume projection equations by integrati the growth functions to produce a five-equati system for estimating growth and yield of loblol pine. Buckman (1962), Curtis (1967), and Mos and Hall (1969) also have developed equatio based on the concept that the yield function is th integral form of the growth function.

Remeasurements on the same plot introdu the problem of correlated errors, which violat one of the basic assumptions of the standar linear model. Sullivan and Clutter (197 modified Clutter's cubic yield equation an projected basal area equation by combining the into a single function. Parameters were e

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[2] Renewable Resources Evaluation Staff. Forest resources inventory work plan. Supp., For. Serv. Handb. 1809.11, 83 p. U.S. Dep. Agric. For. Serv., South. For. Exp. Stn.

[3] Includes only counties in the Coastal Plain.

Table 2. *Volume by State and diameter class of loblolly pine growing stock on commercial forest land west of the Mississipp River*

			Diameter Class (inches at breast height)									
State	Date of Survey	All classes	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0 and larger
			Million cubic feet									
Arkansas	1969	2,603.8	250.2	283.5	357.9	398.5	374.1	313.9	246.8	173.5	196.7	8.7
Louisiana[1]	1974	4,804.6	383.3	614.0	650.4	690.4	668.9	523.7	470.6	319.8	449.1	34.4
Oklahoma	1976	63.7	3.7	6.7	10.1	6.2	10.3	2.8	5.0	10.2	8.7	------
Texas	1975	5,186.8	339.9	545.2	721.8	808.0	779.9	655.1	513.3	367.2	429.9	26.5
All States		12,658.9	977.1	1,449.4	1,740.2	1,903.1	1,833.2	1,495.5	1,235.7	870.7'	1,084.4	69.6

[1] Excludes southeast Louisiana parishes.

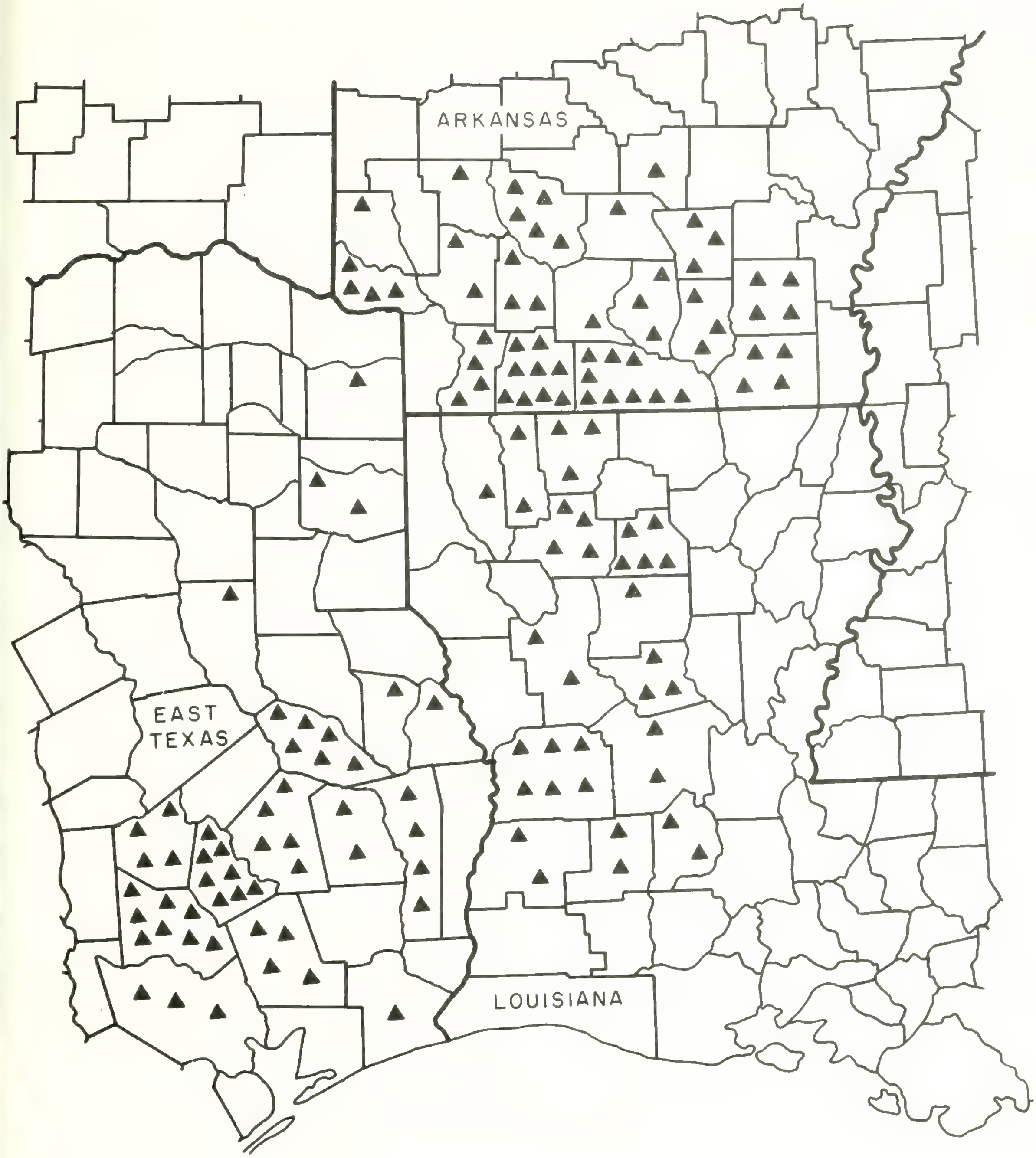

Figure 1.— *Geographical distribution of loblolly pine sample plots in Arkansas, Louisiana, and Texas.*

Table 3.— *Plot distribution by age, site index, and loblolly basal area at remeasurement*

Age	Site index	Basal area per acre						
years	*feet*	*square feet*						
		≤ 20	21-40	41-60	61-80	81-100	100+	Total
11-20	70	----	----	----	----	----	----	0
	80	----	----	----	----	----	----	0
	90	----	----	----	----	----	----	0
	100	----	1	1	----	----	----	2
	110+	----	----	----	----	----	----	0
	Total	0	1	1	0	0	0	2
21-30	70	1	----	----	----	----	----	1
	80	----	3	----	1	1	----	5
	90	1	3	4	2	----	----	10
	100	----	1	2	3	1	3	10
	110+	----	2	2	3	2	----	9
	Total	2	9	8	9	4	3	35
31-40	70	----	4	3	2	1	----	10
	80	1	2	9	2	3	1	18
	90	----	4	6	10	5	1	26
	100	----	----	----	3	4	2	9
	110+	----	----	----	----	----	1	1
	Total	1	10	18	17	13	5	64
41-50	70	----	1	----	----	1	----	2
	80	----	1	1	1	2	2	7
	90	----	----	2	3	----	7	12
	100	----	----	----	2	1	2	5
	110+	----	----	----	----	----	----	0
	Total	0	2	3	6	4	11	26
51-60	70	----	1	----	1	----	----	2
	80	----	----	----	1	----	1	2
	90	----	----	----	1	2	----	3
	100	----	----	----	3	----	1	4
	110+	----	----	----	----	----	----	0
	Total	0	1	0	6	2	2	11
61+	70	----	----	1	----	----	----	1
	80	----	----	----	2	1	----	3
	90	----	----	----	1	1	1	3
	100	----	----	----	----	----	----	0
	110+	----	----	----	----	----	----	0
	Total	0	0	1	3	2	1	7
All ages	70	1	6	4	3	2	0	16
	80	1	6	10	7	7	4	35
	90	1	7	12	17	8	9	54
	100	0	2	3	11	6	8	30
	110+	0	2	2	3	2	1	10
	Total	3	23	31	41	25	22	145

timated by maximum likelihood. The fact that errors between two measurements of the same plot were correlated was taken into account in the maximum likelihood procedure. Seegrist and Arner (1978) extended this maximum likelihood procedure to more than one remeasurement.

Furnival and Wilson (1971) dealt with the problems of estimating parameters in a system of equations to predict growth and yield of forest stands. They pointed out that using ordinary least squares may not be an appropriate means of estimation: often it is necessary to treat a variable as both independent and dependent; coefficients in one equation may be related to coefficients in other equations; and residuals from equations may be correlated. They described several simultaneous equation techniques widely used in econometrics that might be applied to growth and yield equation systems. These techniques explicitly treat the problems of equation systems. One such technique, three-stage least squares (3SLS), is applied here to an equation system that estimates cubic yield and basal area of even-aged stands of loblolly pine.

Model Development

The equations are those of Clutter (1963) and Sullivan and Clutter (1971). In modified form, they are:

$$\text{(1)}\quad E(\ln B_2) = \ln(B_1)A_1/A_2 + a_1(1-A_1/A_2) + a_2(1-A_1/A_2)\ln(B_1) + a_3(1-A_1/A_2)\ln(B_1)^2$$

$$\text{(2)}\quad E(\ln V_2) = \beta_0 + \beta_1 S + \beta_2 A_2^{-1} + \beta_3(\ln B_2)$$

where

A_i = stand age at the ith occasion

B_i = basal area in square feet per acre of loblolly pine trees 5 inches in diameter and greater at breast height

S = site index in feet at base age 50

V_i = cubic volume (inside bark) per acre of loblolly pine trees 5 inches in diameter and greater at breast height from a 1-foot stump height to a 4-inch top diameter, outside bark

a_i, β_i = parameters to be estimated.

The symbol E(...) denotes expected value of the quantity within the parantheses. The form of the basal area equation (1) was suggested by Seegrist.[4]

Variables in simultaneous equation models may be designated by standard econometric terminology (Furnival and Wilson 1971, Theil 1971, Pindyck and Rubinfeld 1976) as exogenous (independent) or endogenous (dependent). The variables stand age A_i and site S in equation (1) are uncontrolled covariates and exogenous to the equation system. The variables $\ln(B_i)$ and $\ln(V_i)$ are endogenous variables. The original set of relationships, equations (1) and (2), are the structural equations.

The estimation procedure depends upon whether unique estimates of parameters can be obtained. If so, the system is said to be exactly identified. If more than one estimate is possible, the system is overidentified. When none is possible, it is unidentified. The degree of identification can be determined by changing the system of equations to its reduced form, where the exogenous variables occur on the right side, and the endogenous variables occur on the left. The reduced form of equation (2) is:

$$\text{(3)}\quad E(\ln V_2) = \lambda_0 + \lambda_1 S + \lambda_2 A_2^{-1} + \lambda_3(A_1/A_2)\ln(B_1) + \lambda_4(1-A_1/A_2) + \lambda_5(1-A_1/A_2)\ln(B_1) + \lambda_6(1-A_1/A_2)\ln(B_1)^2$$

where $\lambda_0 = \beta_0$, $\lambda_1 = \beta_1$, $\lambda_2 = \beta_2$, $\lambda_3 = \beta_3$, $\lambda_4 = \beta_3 a_1$, $\lambda_5 = \beta_3 a_2$ and $\lambda_6 = \beta_3 a_3$.

Equation (1) is in reduced form. Estimates of the model parameters can be determined from those of the reduced form equations. Examination of the reduced form equations shows that there are two sets of estimates for the parameters a_1, a_2, and a_3. One set comes directly from equation (1), and the other is $a_1 = \lambda_4/\lambda_3$, $a_2 = \lambda_5/\lambda_3$, $a_3 = \lambda_6/\lambda_3$.

Since the system is overidentified and the endogenous variables probably are correlated, using ordinary least squares is inappropriate. Two-stage least squares (2SLS) could be used to estimate the parameters of an overidentified system. The basal area equation (1) is fitted using ordinary least squares, and expected values are used as independent variables in fitting equation (2). But using 3SLS is more efficient because it takes account of possible correlation in errors between equations in overidentified systems.

The 3SLS is an extension of 2SLS. Estimates of the second stage are used to obtain estimates of residuals. Residuals are used to obtain estimates of cross-equation correlations. Zellner and Theil (1962) originated this technique, and estimates obtained are consistent. The efficiency of 3SLS ususally exceeds that of the two-stage procedure. Its efficiency is matched by 2SLS only if there are no correlated errors between the system equations (Madansky 1964).

But 3SLS would not estimate the likely serial correlation between original and remeasured observations in equation (2). However, equation (2) can be decomposed into two components — a function that predicts current yield and another that forecasts future volume — so that these three equations can be solved:

$$\text{(4)}\quad E(\ln B_2) = \ln(B_1)A_1/A_2 + a_1(1-A_1/A_2) + a_2(1-A_1/A_2)\ln(B_1) + a_3(1-A_1/A_2)\ln(B_1)^2$$

$$\text{(5)}\quad E(\ln V_1) = \beta_0 + \beta_1 S + \beta_2 A_1^{-1} + \beta_3 \ln(B_1)$$

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[4] Personal communication, March 5, 1979.

$$(6)\quad E(\ln V_2) = \beta_0 + \beta_1 S + \beta_2 A_2^{-1} + \beta_3 \ln(B_2).$$

Data were evaluated with the Statistical Analysis System (SAS) 3SLS procedure (Barr, Goodnight, Sall, Helwig 1976) that handles side conditions on the parameters.

Results

The results of analyses are shown in table 4. Cross-equation correlations of residuals from the second stage of the analysis are:

$$\begin{array}{cc} & \begin{array}{ccc} \ln(B_2) & \ln(V_1) & \ln(V_2) \end{array} \\ \begin{array}{c} \ln(B_2) \\ \ln(V_1) \\ \ln(V_2) \end{array} & \left[\begin{array}{ccc} 1.0 & -.34457 & -.37965 \\ -.34457 & 1.0 & .60611 \\ -.37965 & .60611 & 1.0 \end{array}\right] \end{array}$$

A negative correlation results between the basal area projection (4) and the two yields (5,6). Also, a stronger correlation results between projected basal area and projected volume than between projected basal area and current yield. Residuals between current and projected yields are positively correlated. The same pattern of correlated errors has been reported by Seegrist and Arner[5]. Sullivan and Clutter (1971) observed a positive correlation between residuals of current versus projected yields.

Although refined estimates of parameters might be obtained by calculating the residuals and obtaining new values for cross-equation correlations, Madansky (1964) found that iterated 3SLS offers no practical gain in efficiency.

Whether any advantage results from using simultaneous equation procedures, such as 3SLS, cannot be settled on the basis of the simple equation system we presented here. But as the prediction of growth and yield evolves from reliance upon a single equation to a set of interdependent ones, the applicability of these techniques becomes increasingly relevant. Furnival and Wilson (1971) and Sullivan and Reynolds (1976) have outlined the hazards of applying ordinary least squares to equation systems. Three-stage least squares has an advantage over other simultaneous equation procedures such as maximum likelihood. Software packages are readily available, and extension to more than one remeasurement is straightforward.

Table 4.— *Estimates of model coefficients and their standard errors*

Parameter	Estimate	Standard Error
α_1	1.55265	0.81079
α_2	1.55846	0.48408
α_3	-0.15086	0.07115
β_0	3.02439	0.12324
β_1	0.00515	0.00114
β_2	-20.17542	1.04924
β_3	1.06693	0.02804

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[5] Personal communication, March 5, 1979.

Table 5.— *Evaluation of model predictions*

		Criterion			
Equation	Mean Value	$\bar{D}$[1]	RMSE[2]	$\bar{D}$%[3]	RMSE%[4]
	Cubic feet			*Percent*	
Current volume V_1	897	82	193	12	30
Projected volume V_2	1,754	-24	235	1	15
	Square feet			*Percent*	
Basal area B_2	69.8	-1.5	8.2	-1	12

[1] Mean difference $\bar{D} = \sum \frac{(\hat{Y}_i - Y_i)}{n}$

[2] Root mean square error RMSE $= \sqrt{\frac{1}{n}\Sigma(\hat{Y}_i - Y_i)^2}$

[3] Percentage of mean difference $\bar{D}\% = \frac{1}{n}\sum\left(\frac{\hat{Y}_i - Y_i}{Y_i}\right) \times 100$

[4] Percentage of root mean square error RMSE% $= \sqrt{\frac{\frac{1}{n}\Sigma(\hat{Y}_i - Y_i)^2}{Y_i^{\,2}}} \times 100$

where n = number of observations, Y_i = actual value, and $\hat{Y}_i$ = predicted value.

Our yield equations accounted for 90.7 and 92.9 percent of the variation about mean cubic-foot volume for current V_1 and projected V_2 stand volumes. The basal area equation explained 91.3 percent of the variation about mean projected basal are B_2.

Table 5 provides information on the prediction performance of the equation system. The mean difference indicates that the current volume equation overestimates volume, and the projected volume and basal area equations give slight underestimates on the average. The root mean square errors penalize large deviations from the observed values more than average differences. Percentage of mean difference and percentage of root mean square error depict error as a proportion of observed values.

Application of the equations is straightforward. Projected basal area can be predicted with the equation

$$(7)\ \ln(B_2)\quad \ln(B_1)A_1\ A_2 + 1.55265(1\text{-}A_1\ A_2) + 1.55846(1\text{-}A_1\ A_2)\ln(B_1) \text{-}\ .15086(1\text{-}A_1\ A_2)\ln(B_1)^2$$

Current and projected yields can be estimated by

$$(8)\ \ln(V)\quad 3.02439 + 0.00515S - 20.17542\ A + 1.06693\ln(B).$$

For example, suppose estimates of current yield and projected volume and basal area in 10 years are wanted for a loblolly pine stand at age 40 with a site index of 85 feet and a basal area of 70 square feet per acre. Current yield estimate is:

$$V_1 = \exp[3.02439 + 0.00515(85) - 20.17542/40 + 1.06693\ln(70)]$$
$$= 1791 \text{ cubic feet.}$$

Projected basal area is:

$$B_2 = \exp\ [\ln(70)40/50 + 1.55265(1\text{-}40/50) + 1.55846(1\text{-}40/50)\ln(70) \text{-}\ .15086(1\text{-}40/50)\ln(70)^2],$$
$$= 89 \text{ square feet.}$$

Projected volume is:

$$V_2 = \exp[3.02439 + 0.00515(85) - 20.17542/50 + 1.06693\ln(89)],$$
$$= 2560 \text{ cubic feet.}$$

Periodic annual increment for merchantable volume would be 77 cubic feet. Figure 2 illustrates cubic yields expected for different densities for site index 90; figure 3 shows projected basal area yields for various initial densities; and figure 4 depicts projected volumes for different initial densities for site index 90. The estimates indicate yields that can be expected from extensive areas of woods-run conditions.

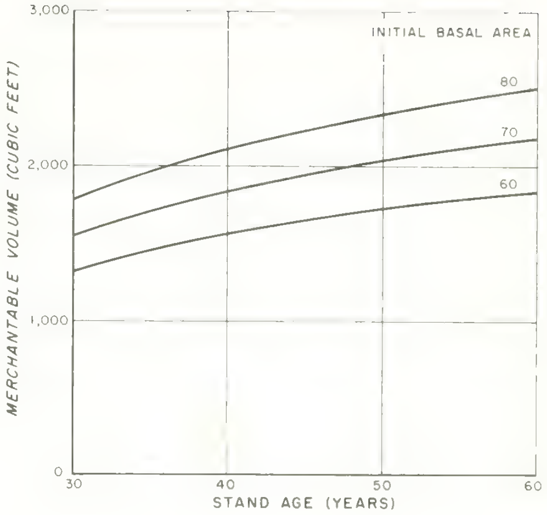

Figure 2.— *Relationship of current yield to basal area and age for natural even-aged loblolly pine stands in the West Gulf Coastal Plain, site index 90.*

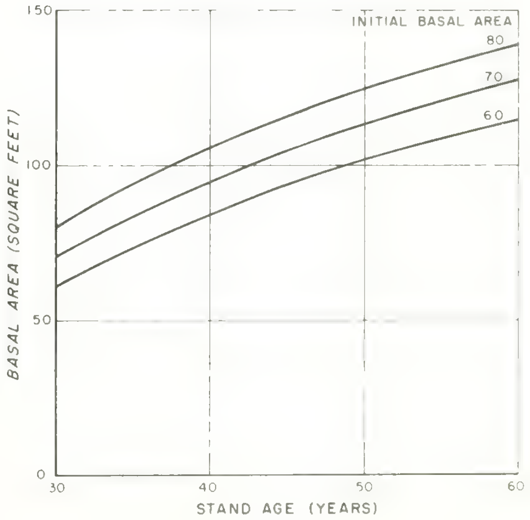

Figure 3.— *Relationship of projected basal area to age and initial basal area at age 30 for natural even-aged loblolly pine stands in the West Gulf Coastal Plain.*

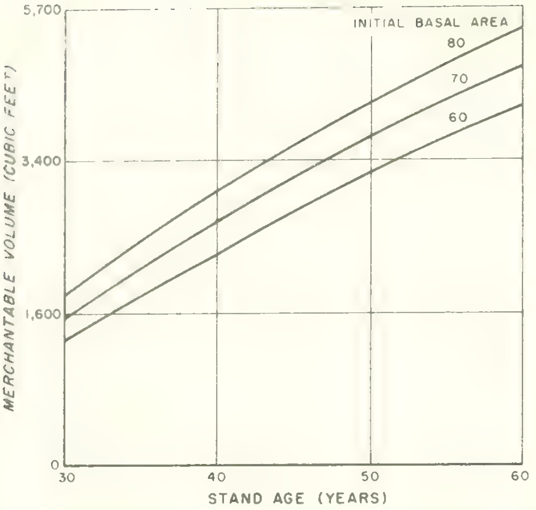

Figure 4.— *Relationship of projected volume to age and initial basal area at age 30 for natural even-aged loblolly pine stands in the West Gulf Coastal Plain, site index 90.*

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Presents an equation system developed to estimate current yield, projected basal area, and projected volume for merchantable natural stands on a per-acre basis. These estimates indicate yields that can be expected from woods-run conditions.

Additional keywords: *Pinus taeda*, volume prediction, basal area projection, stand volume, natural stand yields.

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Family Differences Influence the Aboveground Biomass of Loblolly Pine Plantations

P. E. POPE AND D. L. GRANEY

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SUMMARY

We compared the aboveground biomass of 4 half-sib families of loblolly pine (*Pinus taeda* L.) 11 years after planting. Total dry weights differed significantly among families in plantations on the same soil type with the same site index. Differences in biomass resulted from differences in stem form and branch size. Distribution of growth — the proportion of tree weight in wood, bark, branches and foliage — was not significantly different by family. Average total dry matter and distribution of dry matter were similar to results achieved in other studies, but average annual production by family differed substantially from previously reported plantation data.

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Family Differences Influence the Aboveground Biomass of Loblolly Pine Plantations

P. E. POPE AND D. L. GRANEY

INTRODUCTION

Loblolly pine (*Pinus taeda* L.) is one of the most important tree species in the southeastern United States. The increasing demand for wood fiber has resulted in greater utilization of harvested trees, including complete aboveground harvesting. However, only limited information is available on the accumulation of biomass in either natural stands (Clark and Taras 1976, 1975) or plantations (Wells and Jorgensen 1975; Switzer and Nelson 1972; Ralston and Prince, 1963; Larsen *et al.* 1976) and does not include data from intermediate-aged plantations of genetically improved seed sources.

Our objective in this study is to determine the effect of family differences on the aboveground biomass of loblolly pine and to compare these results with published data for plantation-grown trees.

PROCEDURE

Seeds from four families of loblolly pine were collected from individual parent trees in natural stands in southern Arkansas. Selection of parent trees was based on rapid growth rate (height and diameter).

Seedlings, separated by family, were grown at the Arkansas State Tree Nursery at Little Rock, Arkansas, and planted as 1-0 stock at the Livestock and Forestry Branch Station, Batesville, Arkansas, in the winter of 1964. Planting design consisted of two 0.20 hectare plots located at random for each family, a total of eight plots. Seedlings were located on a 1.83 x 1.83 m spacing (6 ft. x 6 ft.) in a flat ridge-top position of a Nixa soil (loamy-skeletal, siliceous, mesic Glossic Fragiudults). The site was an unimproved pasture that had been abandoned several years earlier. Based on the sample trees, at age 11 these unthinned stands averaged 14.2 cm d.b.h. and 9.8 m in height and had a stocking equivalent to 2990 stems/ha. Site index for sample trees was 20.73 m (68 ft.) at age 25 by the curves of Clutter and Lenhart (1968) and 18.29 m (60 ft.) after Smalley and Bower (1971). Average live crown ratio of sample trees was 27 percent and was not significantly different by family.

In April, 1975, before the 12th growing season, all trees, excluding border rows, were numbered and height (h), diameter at breast height (d), and diameter at base of live crown (d_c) were recorded. Before thinning, six sample trees (10% sample) were selected at random from each plot; care was taken to avoid losses in biomass during felling and subsequent handling. Forty-eight harvested trees, 12 from each family, were sampled. Average height, diameter, stocking, and basal area are presented in table 1.

Table 1.— *Average tree and stand characteristics in four families of 11-year-old loblolly pine*

Family	Height m	D.b.h. cm	No. of Trees per ha	Basal Area m²/ha
1	9.9	14.7	2990	50.96
2	10.0	14.4	2990	49.22
3	9.5	12.9	2990	39.39
4	9.9	14.9	2990	52.73
Mean	9.8	14.2	2990	47.93

Harvested sample trees were separated into foliage, branch, and stem components, and fresh weight of each component was determined. A ten percent subsample (by weight) was collected from foliage and branch components to determine dry-to-fresh weight and foliage-to-branch weight ratios. Branch subsamples were collected by removing one branch from each whorl along the stem. The amount of branch material collected at each internode position was based on the average diameter of the internode and its length.

Stems of sample trees were cut into 1.5 m lengths beginning at ground line. A 5 cm thick

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disc was removed from the base of each section to determine diameter and to estimate dry-to-fresh weight and bark-to-wood weight ratios. Fresh weights of stem sections and discs were determined, and subsamples were dried at 65°C to a constant weight.

We conducted an analysis of variance (ANOVA) to determine the effect of family on total dry matter accumulation and a Duncan's multiple range test for those variables significant in the ANOVA test.

The regression model used to estimate component dry weight values for each family was

$$\log Y = a + b \log X$$

where the lower case letters were constants and X was the combined variable d^2h (diameter at 1.37 meters x total tree height) for stem and foliage and d_c (diameter at the base of the live crown) for branch components (Madgwick 1971). All estimates of weight using regressions incorporated the multiplicative correction for bias suggested by Finney (1941).

$$e^{\frac{1}{2}S^2} \left[1 - \frac{S^2 (S^2 + 2)}{4n} + \frac{S^4 (3S^4 + 4S^2 + 84)}{96n^2} + \ldots \right]$$

were S^2 is the variance of logarithm weight and n is the number of observations.

RESULTS AND DISCUSSION

Basal Area

Eleven-year-old stands grown from open-pollinated seed of four loblolly pine trees differed significantly in diameter at breast height (d.b.h.) and basal area (table 1).

Dry Matter

Average total dry matter accumulation was 88.5×10^3 kg/ha (fig. 1). Stand data for individual families vary significantly from the overall average. Families 1-4 differed from average total biomass by +8, -11, -22, and +25 x 10^3 kg/ha with a difference of 47 x 10^3 kg/ha for families with highest (4) and lowest (3) means. Differences in total dry weight result mainly from differences in dry weight of stem and branch components. Family 4 accumulated the greatest dry weight for each component, followed in order by 1, 2, and 3.

Compared to the overall average component weights of 56.25 x 10^3 kg/ha for stem, 7.3 x 10^3 kg/ha for bark, 19.0 x 10^3 kg/ha for branches, and 6.06 x 10^3 kg/ha for the foliage, the difference from average dry weight by family (1-4 in order) was +5.4, -7.85, -14.80, and +17.15 for stem; +0.11, -0.57, -0.77, and +1.26 for bark; +1.44, +0.21, -7.37, and +5.70 for branches, and +1.06, -2.84, +0.79, and +1.06 for foliage.

Differences in stem weight seem to be related more to tree diameter and form than to variation in specific gravity. Values for specific gravity (green volume and oven dry weight basis) taken at d.b.h. averaged 0.46 and were not significantly different (a = .05) among families. Average height to a 2-inch top for families 1-4 is 8.62, 8.75, 7.78, and 8.99 meters. Stem taper appears to be affected by family and can substantially affect dry weight yields of merchantable stem wood. A similar relationship exists between average branch diameter and total branch weight by family. As average branch diameter increased, so did total dry weight, in the order family 4, 1, 2 and 3.

Valid comparisons with published data for loblolly pine are difficult because of varying age, site index, stocking, stand condition, and method of data collection. Stand data for average total biomass and biomass by component, except for foliage, are in agreement with data presented by Larsen *et al.* (1976) for 13-year-old loblolly pine plantations in the hilly Coastal Plain of Alabama. Foliage weight exceeds by about 20 percent the average value reported for stands of about the same age and site index (such differences could result from the high stocking levels of our study) but is 34 percent less than the average reported by Larsen *et al.* (1976) and 21 percent less than that reported by Wells *et al.* (1975). Those studies were conducted in late summer before needle fall while ours was completed in early spring before needle formation.

Our measurements of average annual and total biomass of plantations are similar to estimates reported for stands of similar age and site index (SI) throughout the South and Southeast (table 2). However, under the same soil and environmental conditions, stands of different genetic makeup having the same site index differ significantly in annual and total biomass production. Comparing our data by family to data reported in other studies indicates that plantations of families 4 and 1 exceed production for genetically unimproved plantations while families 2 and 3 are average or below average in production. Results support the conclusion that yield data for genetically unimproved plantations

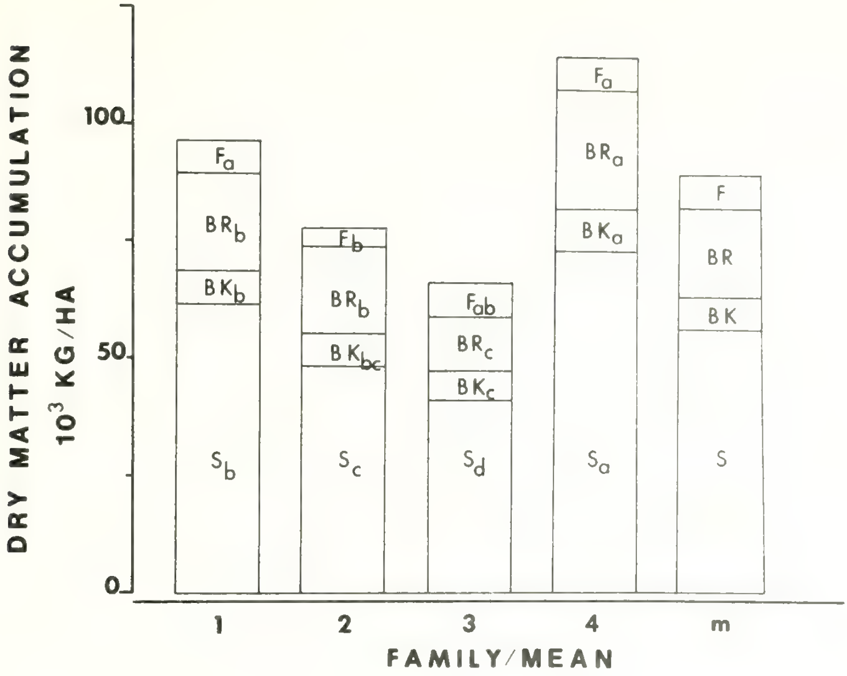

Figure 1.— *Dry matter accumulation and current foliage mass per hectare by plant component for four families of 11-year-old loblolly pine. Tree components are stem (S), bark (BK), branches (BR), and foliage (F). Tree components not followed by the same letter are significantly different (a = .05).*

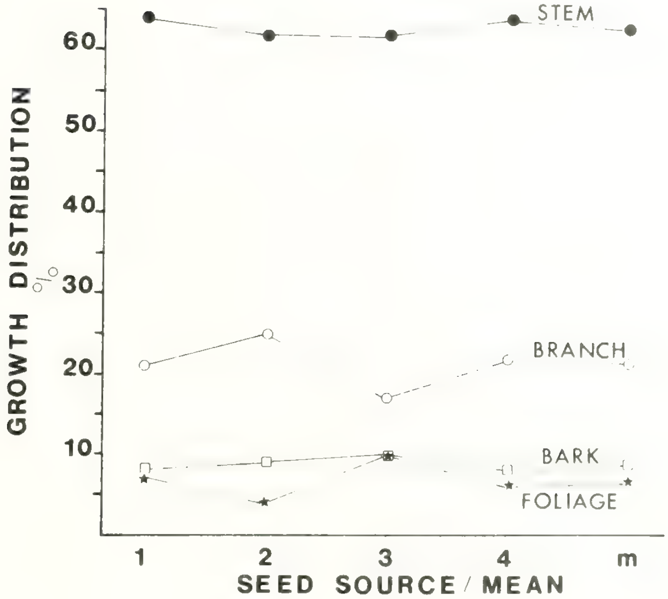

Figure 2.— *Effect of seed source (family) on distribution of growth to stem, branch, bark and foliage components for 11-year-old loblolly pine plantations.*

Table 2.— *Comparison of aboveground biomass in loblolly pine stands at various locations*

		Biomass				
Location and Reference	Age	Total	Annual	Current	Site index	
		t/ha	----------t/ha/yr----------		----------meters----------	
Ala., Larsen et al. (1976)	13	88.5	6.81	. . . .	19.82	
S.C., Metz and Wells (1965)	13	52.6	4.05	. . . .	18.29	
Miss., Smith et al. (1971)	4	6.3	1.6	. . . .	. . . .	
	5	15.7	3.1	9.4	. . . .	
Miss., Switzer et al. (1966)	18	70.0	3.9	. . . .	18.29	
N.C., Wells et al. (1975)	16	148.0	9.25	. . . .	20.73	
N.C., Nemeth (1972) and	14	77.4	7.0	. . . .	. . . .	
Wheeler (1972)	15	90.6	7.6	12.2	. . . .	
Ralston et al. (1972)	14	75.5	5.4	. . . .	. . . .	
	15	91.1	6.1	. . . .	. . . .	
					Clutter & Lenhart, 1968	Smalley & Bower, 1971
Present Study (Mean)	11	88.5	8.05		20.73	18.29
Family						
1	11	96.5	8.77		20.73	18.29
2	11	77.5	7.05		20.73	18.29
3	11	66.5	6.05		20.73	18.29
4	11	113.5	10.32		20.73	18.29

Table 3.— *Dry matter distribution (%) of the aboveground biomass of loblolly pine plantations at various locations*

		Growth Distribution (%)				
Location and Reference	Age	Stem	Live branch	Dead branch	Bark	Foliage
N.C., Wells et al. (1975)	16	70	9	7	10	5
S.C., Metz & Wells (1965)	13	55.7	19.7[1]	19.7[1]	12.9	9.7
Ala., Larsen et al. (1976)	13	58	14	9	9	11
Ark., Ku & Burton (1973)	19	72	9	5	9	4
Present Study	11	63	21[1]	21[1]	9	7

[1] Total represents live and dead branches combined.

cannot be applied where genetically improved material is planted even though site indexes might be equivalent. These data also suggest that yield tables for specific families or seed sources may be necessary to predict dry matter or volume production.

Growth Distribution

The largest percentage of dry matter is in bole wood, followed in order by branches, bark, and dormant season foliage (table 3). Relative percentage of foliage in growth distribution rankings will increase after development of first-year needles, making the amount of growth distributed to the bark the least. On the average, 63 percent of dry matter is in bole wood, 9 percent in bark, 21 percent in branches, and 7 percent in dormant season foliage (fig. 2). Distribution of dry matter among stem wood and bark is not significantly ($\alpha = .05$) different between families, though the variation was 2-6 percent for stem wood and 3-5 percent for bark. Similar results were obtained for branch and foliage components; however, family 3 had a significantly higher percentage of dry matter in foliage and a lower percentage in branches.

Production of foliage has been estimated from values of standing biomass which assume that production is equal to weight of one-year-old needles on the tree at the end of the growing eason. Such an assumption overlooks both ecline (if any) in weight of individual leaves at he end of the growing season and actual foliage oss (Bray and Gorham 1964). Using weight of eaves on trees at the end of the growing season will lead to underestimates. However, estimates of stand canopy mass based on logarithmic regressions such as we used tend to overestimate foliage biomass between 1 and 9 percent (Satoo 1965). Madgwick (1971) reported that estimates of needle biomass using either trees of mean basal area or a random sampling were not improved when compared to the regression approach but were significantly underestimated.

Branch biomass reflects many factors, including annual production, death, and decay rates. Accurately estimating branch productivity of stands is difficult (Madgwick 1970), but estimates of live branch biomass using d_c as the regressor variable can be expected to give only slight underestimates (Madgwick 1971). Madgwick (1971) reported that mean estimated stand weights of boles were within 2 percent of actual stand weights regardless of sampling technique or regression variable used.

Dry matter distribution among aboveground tree components reported in our study is similar to that reported elsewhere (table 3). For well-stocked, intermediate-aged stands of a similar age and site quality, genotype apparently has little influence on relative distribution of dry matter. Growth distribution may be more a function of stand age and spacing. Previously established yield tables and biomass distribution by tree component for genetically unimproved plantations could be appropriate for estimating percentages of dry matter distribution in genetically improved plantations.

SUMMARY

For well-stocked stands of similar age and site quality, family differences affect the total production of dry matter but apparently do not affect the distribution of dry matter among bark, branches, and stems.

On genetically improved plantations, dry matter production can differ substantially from that on genetically unimproved plantations, even when site index, age, and level of stocking are equivalent. Our results suggest that yield tables for specific genotypes may be necessary to predict fiber yields.

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Compares the aboveground biomass of 4 half-sib families of loblolly pine (*Pinus taeda* L.) 11 years after planting. Total dry weights differed significantly among families in plantations on the same soil type with the same site index. Distribution of growth was not significantly different by family.

Additional keywords: Genotype, biomass, growth distribution, *Pinus taeda*

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Growth and Yield Predictions for Thinned Stands of Even-aged Natural Longleaf Pine

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Southern
Forest
Experiment
Station

SUMMARY

This paper presents a system of equations and resulting tables that can predict stand volumes for thinned natural longleaf pine. The system can predict current and future total stand volume in cubic feet and merchantable stand volume in cubic feet, cords, and board feet. The system also provides for estimating dry-weight production of wood. The system uses input data on present and future age, site index, and present basal area. By using the tables, the timber grower can predict volume production for a variety of initial stand conditions, thinning regimes, and rotation lengths.

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Growth and Yield Predictions for Thinned Stands of Even-aged Natural Longleaf Pine

ROBERT M. FARRAR, JR.

INTRODUCTION

Interest in longleaf pine (*Pinus palustris* Mill.) is enjoying a revival. Encouraged by longleaf's high quality and marketability, many landowners are taking advantage of recent improvements in longleaf regeneration techniques (Mann 1969, 1970; Croker and Boyer 1975) and growing it today.

For successful longleaf management, timber growers must be able to predict growth and yield for various management alternatives. Some guidance exists in yield tables for unthinned stands (Schumacher and Coile 1960; U.S. Department of Agriculture, Forest Service, 1976), and several reports on thinning study results (for example, Chapman 1951, Gaines 1951; Farrar 1968, 1974).

This information, though useful, fails to give needed growth and yield predictions for a comprehensive array of stand ages, site qualities, and residual densities maintained by periodic thinning. To meet this need, the Southern Forest Experiment Station established a regional longleaf pine growth study starting in the mid-1960's.

Using data from the first 5-year growth period, this paper describes a system for predicting growth and yield in total stand volume in cubic feet, and merchantable stand volume in cubic feet, cords, and board feet (fbm). The system can also estimate dry-weight production of wood.

METHODS[1]

Field Procedures

The study comprises 175 permanent 1/5-acre plots, established with the cooperation of public and private landowners (see Acknowledgments), in even-aged natural stands of longleaf pine, in northwest Florida, southwest Georgia, south and central Alabama, and south Mississippi.

Plots were chosen in a broad array of stand age, site index, and residual basal area classes (table 1). To be chosen, plots had to be at least 80 percent longleaf, by basal area, before cutting (100 percent after cut); uniform in age, site index, and density; and free of damage from insects, disease, wildfire, turpentining, etc. All hardwoods with d.b.h. ≥ 1 inch were killed initially.

Most plots have been prescription-burned every 3–5 years. This prescribed burning is intended to control woody vegetation regrowth and reduce wildfire hazard.

Initial field measurements included numbering and tallying all living longleaf stems with d.b.h. ≥ 0.6 inch and recording crown class (SAF 1958) for each tree. For height determination, a sample of trees was mechanically

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[1] Farrar (1978) details all field procedures and most analysis methods.

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selected from each 1-inch d.b.h. class (see Farrar 1978). A subsample of dominant and codominant trees was chosen for stand age and site index determination.

All trees with d.b.h. < 0.6 inch were destroyed. Plots were thinned mostly from below. This thinning left specified residual basal areas.

Field procedures are the same at remeasurement, which is done every 5 years. The amount and causes of mortality are identified. Plots are rethinned to initial levels if their basal area has grown more than 1/4 of the way toward midpoint of the next higher basal-area class.

Data Summary

I calculated plot volumes per acre by using regression to predict total height for each living tree given its observed d.b.h., in inches, (D). Then, D and predicted total height, in feet, ($\hat{H}$) were used as arguments in the following equations:

(1) $M\hat{V}I_0 = 0.00535 + 0.0021971(D^2\hat{H})$

(2) $M\hat{V}O_0 = (M\hat{V}I_0)(1.+(10.^{-\text{[illegible]}})(M\hat{V}I_0)^{\text{[illegible]}})$

(3) $M\hat{V}I_3 = (M\hat{V}I_0)/(1.+(10.^{-0.5493})(M\hat{V}I_0)^{-1.3024})$

(4) $M\hat{V}O_3 = (M\hat{V}I_3)(1.+(10.^{-\text{[illegible]}})(M\hat{V}I_3)^{\text{[illegible]}})$

(5) $M\hat{V}I_7 = (M\hat{V}I_0)/(1.+(10.^{1.161})(M\hat{V}I_0)^{-1.5844})$

(6) $M\hat{V}O_7 = (M\hat{V}I_7)(1.+(10.^{-0.30925})(M\hat{V}I_7)^{-0.21895})$

(7) $$F\hat{B}M = -10.385 + 0.70341(\hat{H}) - 0.011555(\hat{H}^2) - 0.000041104(\hat{H}^3) - 0.54873(D^2) + 0.010111(D^2\hat{H}) + 0.00023546(D^2\hat{H}^2) - 0.002509(D^4) + 0.000096682(D^4\hat{H}) - 0.0000013064(D^4\hat{H}^2) + 0.0000063791(D^6) - 0.00000018759(D^6\hat{H}) + 0.0000000018927(D^6\hat{H}^2)$$

where:

$M\hat{V}I_0$=predicted tree total volume, i.b., in cubic feet; d.b.h. ≥ 0.6 inch; 0.2-ft stump

$M\hat{V}O_0$=predicted tree total volume, o.b., in cubic feet; d.b.h. ≥ 0.6 inch; 0.2-ft stump

$M\hat{V}I_3$=predicted tree merchantable volume, i.b., in cubic feet; d.b.h. ≥ 3.6 inches; top d.o.b.=3 inches; 0.2-ft stump

$M\hat{V}O_3$=predicted tree merchantable volume, o.b., in cubic feet; d.b.h. ≥ 3.6 inches; top d.o.b.=3 inches; 0.2-ft stump

$M\hat{V}I_7$=predicted tree merchantable volume, i.b., in cubic feet; d.b.h. ≥ 7.6 inches; top d.o.b.=7 inches; 0.2-ft stump

$M\hat{V}O_7$=predicted tree merchantable volume, o.b., in cubic feet; d.b.h. ≥ 7.6 inches; top d.o.b.=7 inches; 0.2-ft stump

$F\hat{B}M$=predicted tree volume, in board feet; Int. 1/4-inch rule; d.b.h. ≥ 6 inches; top d.i.b.=5 inches; 1-ft stump.

Equation 1 is from Farrar (1978) and is based on observed volume data from 224 felled natural longleaf trees. Equations 2–6 are also derived from these data. Equations 1–6 account for about 97.4 to 99.0 percent of the variation around mean observed volumes and have root mean square deviations of 2.04 to 3.32 ft^3. Equation 7 was developed from table 13 of Misc. Publ. 50 (U.S. Dep. Agric. For. Serv. 1976). Tabular data for 72 trees with d.b.h. ≥ 6 inches, and observations on 7 larger trees (up to 22 inches d.b.h.), were used to develop equation 7. Fit statistics for equation 7 are: R^2=0.995; $S_{y.x}$ =±10.5.

Living-tree volumes were summed and converted to an acre basis. This operation gives:

TVI_1=initial stand total volume, i.b., in cubic feet; d.b.h. ≥ 0.6 inch; 0.2-ft stump

TVI_2=final value for TVI at the end of the 5-year period

TVO_1=initial stand total volume, o.b., in cubic feet; d.b.h. ≥ 0.6 inch; 0.2-ft stump

Table 1.—*Distribution of plots at beginning of 5-year growth period according to site index, age, and residual basal area*

Site index (feet)	Age (years)	Basal area per acre (square feet)					
		<16	16 to 45	46 to 75	76 to 105	106 to 135	≥136
		No. of Plots					
46 to 55	11 to 30	1	2	....	....	....	....
	31 to 50	....	1	2	3	2	....
	51 to 70	....	1	....	1	1	1
	71 to 90	....	1	1	1	1	....
56 to 65	11 to 30	2	7	2	....	....	....
	31 to 50	....	2	2	2	3	1
	51 to 70	....	2	3	1	1	2
	71 to 90	....	1	....	1	....	....
66 to 75	11 to 30	1	7	7	....	1	....
	31 to 50	....	3	1	4	2	2
	51 to 70	....	2	4	5	5	1
	71 to 90	....	1	2	2	....	1
76 to 85	11 to 30	....	1	2	2	2	1
	31 to 50	....	1	2	2	2	3
	51 to 70	....	3	3	2	2	2
	71 to 90	....	....	....	1	....	....
86 to 95	11 to 30	....	....	....	....	....	....
	31 to 50	....	2	1	....	....	....
	51 to 70	....	1	1	....	1	....
	71 to 90	....	....	....	....	....	....

TVO_2=final value for TVO at the end of the 5-year period

$V4I_1$=initial stand merchantable volume, i.b., in cubic feet; d.b.h. ≥ 3.6 inches; top d.o.b.=3 inches; 0.2-ft stump

$V4I_2$=final value for V4I at the end of the 5-year period

$V4O_1$=initial stand merchantable volume, o.b., in cubic feet; d.b.h. ≥ 3.6 inches; top d.o.b.=3 inches; 0.2-ft stump

$V4O_2$=final value for V4O at the end of the 5-year period

$V10I_1$=initial stand merchantable volume, i.b., in cubic feet; d.b.h. ≥ 9.6 inches; top d.o.b.=7 inches; 0.2-ft stump

$V10I_2$=final value for V10I at the end of the 5-year period

$V10O_1$=initial stand merchantable volume, o.b., in cubic feet; d.b.h. ≥ 9.6 inches; top d.o.b.=7 inches; 0.2-ft stump

$V10O_2$=final value for V10O at the end of the 5-year period

BF_1=initial stand volume, in board feet; d.b.h. ≥ 9.6 inches; top d.i.b. =5 inches; 1-ft stump

BF_2=final value for BF at the end of the 5-year period.

Quadratic-mean stand d.b.h. was calculated as:

$\overline{D}_1$=initial quadratic-mean d.b.h. in inches, d.b.h. ≥ 0.6 inches

$\overline{D}_2$=final value for $\overline{D}$ at the end of the 5-year period.

Stand basal areas were calculated for all living trees at the start (B_1) and end (B_2) of the period by:

$$B=0.005454\left(\sum_{j=1}^{n}(D_j^2)\right)(K) \tag{8}$$

where:

B=stand basal areas per acre on the plot, d.b.h. ≥ 0.6 inch

D_j=d.b.h. of the jth tree on the plot

K=appropriate per-acre conversion factor

n=number of trees on the plot.

I predicted stand site index by calculating plot average age (A) and average dominant height (H_D) for the sample dominant and codominant trees. Tree age, dated from seed, is the ring count at 4-ft height plus 7 years. Plot A and H_D were then used in the following equation:

$$S=(H_D)(10.)^{[f(50)-f(A)]} \tag{9}$$

where:

S=stand site index in feet; index age 50 years

$f(50)=b_1/50+b_2/(50)^2+b_3/(50)^3+b_4/(50)^4$

$f(A)=b_1/A+b_2/A^2+b_3/A^3+b_4/A^4$

b_1=-29.468

b_2=938.97

b_3=-16102

b_4=88775

Farrar (1978) details the development of this site-index function. Site index is estimated by equation 9 in all stand growth and yield predictors below.

Data Analysis

In the analysis, 139 plots were used. Of the original 175 plots, five were lost to trespass-cutting before remeasurement; 31 plots were omitted because of too much mortality in the dominant and codominant crown classes and suspected adverse effects of disease and site alteration caused by a raised water table. Otherwise, any mortality in the suppressed and intermediate crown classes was tolerated.

So, the plots used in this analysis represent the net volume growth and yield one might expect in the absence of catastrophic mortality or other adverse influences.

Table 1 shows the distribution of these 139 plots by initial age, site index, and residual basal area. Initially, individual plots ranged in age from 15-80 years, in site index from 46-90 ft and in residual basal area from 8-169 ft^2 per acre.

I fitted a modified form of Sullivan and Clutter's (1972) simultaneous growth and yield prediction models by least squares, using 139 observations on initial stand conditions and 139 observations on final stand conditions. The resulting equations 10-12 predict current and projected stand total cubic-foot volume, i.b., (TVI) and projected stand total basal area (B) in relation to stand age (A), site index (S), and basal area.

I predicted stand total volume, o.b., in cubic feet (TVO) by using a fitted function that estimates the ratio of TVO to TVI in terms of A, S and B using 278 observations on stand conditions. Predicting TVO by the models used to predict TVI resulted in equations that intersected; so, for certain otherwise reasonable combinations of A, S, and B, the $\widehat{TVI}$ exceeded the $\widehat{TVO}$. To avoid this logical impossibility, I predicted the ratio TVO/TVI by a function of the form $1.+e^{[f(A, S, B)]}$ that, when multiplied times estimates of TVI, gives estimates of TVO that are always greater than TVI.

These equations projecting total basal area and current and future total volume also form the basis for the predictors of merchantable volume below.

I predicted merchantable volumes, i.b. and o.b., by using fitted functions that estimate the ratio of a larger to a smaller value for given stand conditions. For example, predicting the ratio of BF/V10I as a function of the form $9-e^{[f(A, S, B)]}$ enables estimates of BF. (Nine is the approximate maximum possible board feet per cubic foot, allowing for kerf and shrinkage.)

$\widehat{BF/V10I}$ can then be multiplied times estimates of V10I to give estimates of BF. Necessary ratio estimators were formulated, fitted, and evaluated. These operations insured that predictors for stand i.b. and o.b. merchantable volumes, in cubic feet, are logically related. For any given stand conditions of A, S, and B, the logical restraints built into the system are:

TVO > TVI, TVO > V4O > V10O, and TVI > V4I > V10I. Two further logical restraints which should occur, V4O > V4I and V10O > V10I, were not insured but do result from system development.

RESULTS

The equations for estimating growth and yield of thinned natural longleaf are:

Basal Area

$$\hat{B}_2 = e^{[(A_1/A_2)\ell n(B_1)+6.0594(1-A_1/A_2)]} \qquad (10)$$

n = 139

where:

$\hat{B}_2$=projected basal area at the end of the period in square feet per acre; d.b.h. ≥ 0.6 inch

e=natural logarithm base

A_1=stand age at the start of the period in years

A_2=stand age at the end of the period in years

ℓn=natural logarithm

B_1=basal area at the start of the period in square feet per acre; d.b.h. ≥ 0.6 inch

n=number of observations involved in fitting the equation.

Total Cubic-Foot Volumes

$$(11)\qquad \hat{TVI}_2 = e^{[2.6776+0.015287(S)-21.909/A_2 +(A_1/A_2)\ell n(B_1)+6.0594(1-A_1/A_2)]}$$

n=278

where:

$\hat{TVI}_2$=projected stand total volume, i.b., in cubic feet per acre at the end of the period; d.b.h. ≥ 0.6 inch, 0.2-ft stump

S=stand site index in feet; index age=50 years

When $A_1=A_2$ and $B_1=B_2$ or the growth period length is 0, then equation 11 reduces to:

$$(12)\qquad \hat{TVI} = e^{[2.6776+0.015287(S)-21.909/A+\ell n(B)]}$$

where:

A, S, B are current stand conditions for age, site index and basal area, and $\hat{TVI}$ is the predicted current stand volume in cubic feet.

The ratio estimator for predicting stand total volume, o.b., in cubic feet is:

$$(13)\qquad (\widehat{TVO/TVI}) = 1.+e^{[-0.17875+43.629/S +1108.6/((S)(B))-0.42802\ell n(A) -360.87\ell n(A)/((S)(B))]}$$

n=278

Then, since (TVI)(TVO/TVI)=TVO:

$$(14)\qquad \hat{TVO} = (\hat{TVI})[1.+e^{\{-0.17875+43.629/S +1108.6/((S)(B))-0.42802(\ell n(A))-360.87(\ell n(A))/((S)(B))\}}]$$

where:

$\hat{TVO}$=predicted stand total volume, o.b., in cubic feet per acre; d.b.h. ≥ 0.6 inch; 0.2-ft stump.

Equation 14 can estimate TVO_1 or TVO_2 by proper use of either initial or final conditions for $\hat{TVI}$, A, S, and B as arguments. Table 2 records "goodness of fit" statistics for equations 10, 11, 12, and 14.

The other stand merchantable volume and average d.b.h. estimators are:

Merchantable Cubic-Foot Volumes

$$(15)\qquad \hat{V4I} = \hat{TVI}/[1.+e^{\{2.623+316.77/S+10201/((S)(B)) -2.8248(\ell n(A))-3326.7(\ell n(A))/((S)(B))\}}]$$

where:

$\hat{V4I}$ = predicted stand merchantable volume in cubic feet per acre, i.b.; d.b.h. ≥ 3.6 inches; top d.o.b.=3 inches; 0.2-ft stump.

Equation 15 is based on 278 observations and can estimate $V4I_1$ or $V4I_2$ with initial or final arguments for $\hat{TVI}$, A, S, and B.

Table 2.—*"Goodness of fit" statistics for stand total basal area and volume predictors*[1]

Predictor	m	r	$\overline{OBS}$	$\overline{d}$	$\overline{\%d}$
B_2	139	0.993	90 ft²	2.0 ft²	2.2
TVI_1	139	0.997	1,886 ft³	-0.6 ft³	1.1
TVI_2	139	0.993	2,373 ft³	8.5 ft³	-0.5
TVO_1	139	0.998	2,446 ft³	-3.3 ft³	0.8
*TVO_2	139	0.993	3,055 ft³	10.7 ft³	-0.3

*Ratio predictors for volume at the end of the period use projected basal area ($\hat{B}_2$) as the argument for basal area (B)

[1] m=number of observations used in evaluating the predictor

r=correlation coefficient for predicted (P) and observed (O) values

$\overline{OBS}$=average observed value=(∑(O))/m

$\overline{d}$=average difference=(∑(P-O))/m

$\overline{\%d}$=average percent difference=[(∑((P-O)/O))/m](100)

$$(16) \qquad V\hat{4}O=T\hat{V}O/[1.+e^{\{2.7285+323.23/S+10429/((S)(B))-2.8742(\ell n(A))-3415.6(\ell n(A))/((S)(B))\}}]$$

where:

$V\hat{4}O$=predicted stand merchantable volume in cubic feet per acre, o.b.; d.b.h. ≥ 3.6 inches; top d.o.b.=3 inches; 0.2-ft stump.

Equation 16 is based on 278 observations and can be used to estimate $V4O_1$ or $V4O_2$ as above.

Sawtimber Volumes

$$(17) \qquad V\hat{1}0I=\hat{V}4I/[1.+e^{\{2.9939-2.7845(\ell n(A))+1281.5/S-217.67(\ell n(A))/S+0.016017(B)\}}]$$

where:

$V\hat{1}0I$=predicted stand merchantable volume in cubic feet per acre, i.b.; d.b.h. ≥ 9.6 inches; top d.o b.=7 inches; 0.2-ft stump.

Equation 17 is based on 196 observations from plots that had initial or final V10I > 0. This equation can estimate $V10I_1$ and $V10I_2$, as above.

$$(18) \qquad V\hat{1}0O=V\hat{4}O/[1.+e^{\{2.6804-2.7335(\ell n(A))+1320.6/S-226.17(\ell n(A))/S+0.016420(B)\}}]$$

where:

$V\hat{1}0O$=predicted stand merchantable volume in cubic feet per acre, o.b.; d.b.h. ≥ 9.6 inches; top d.o.b.=7 inches; 0.2-ft stump.

Equation 18 is based on 196 observations from plots that had initial or final V10O > 0. This equation can be used to estimate $V10O_1$ or $V10O_2$, as above.

Cubic-foot volume in sawtimber is estimated as V10I or V10O. The remaining cubic-foot volume in pulpwood (volume in trees with d.b.h. between 3.6 and 9.5 inches, inclusive, to a 3-inch d.o.b. top plus volume in tops of sawtimber trees between 3- and 7-inch d.o.b. tops) can be estimated as (V4I-410I) or (V4O-V10O).

$$(19) \qquad B\hat{F}=(V\hat{1}0I)[9.-e^{\{-0.029925-0.00057658(B)+61.114/S+13.072/A\}}]$$

where:

$B\hat{F}$=predicted stand board-foot volume per acre, Int. 1/4-inch rule; d.b.h. ≥ 9.6 inches; top d.i.b.=5 inches; 1-ft stump.

Equation 19 is based on 196 observations from plots that had initial or final BF > 0. This equation can be used to estimate BF_1 and BF_2, as above. Table 3 gives fit statistics for all these stand merchantable volume predictors.

Mean d.b.h.

$$(20) \qquad \hat{\bar{D}}=-1.6525+0.0015219(A^2)+0.0051269(A)(S)-0.00095789(A)(B)-0.000046415(A^2)(S)+0.0000077625(A^2)(B)$$

where:

$\hat{\bar{D}}$=predicted quadratic-mean stand d.b.h.; all trees with d.b.h. ≥ 0.6 inch. (This is the d.b.h. of the tree of average basal area.)

Equation 20 is based on 278 observations and can estimate initial ($\bar{D}_1$) or final quadratic-mean stand d.b.h. ($\bar{D}_2$). Equation 20 has an R^2=0.942 and $s_{y.x}$=±0.895.

Cord Volumes

$$(21) \qquad C5=(T\hat{V}I)(0.0126-0.0056/\hat{\bar{D}}-0.01989/(\hat{\bar{D}})^2)$$

where:

C5=estimated rough cords per acre; d.b.h. ≥ 5 inches; top d.o.b.=4 inches; 0.7-ft stump.

Table 3 – "*Goodness of fit" statistics for stand merchantable volume predictors*[1]

Predictor	m	r	$\overline{\text{OBS}}$	$\bar{d}$	$\overline{\%d}$
$V4I_1$	139	.994	1792 ft^3	2.0 ft^3	17.8
*$V4I_2$	139	.990	2280 ft^3	22.1 ft^3	- 0.3
$V4O_1$	139	.994	2308 ft^3	21.6 ft^3	6.2
*$V4O_2$	139	.990	2923 ft^3	33.1 ft^3	0.003
$V10I_1$	93	.961	1323 ft^3	10.3 ft^3	20.6
*$V10I_2$	103	.966	1563 ft^3	2.8 ft^3	14.5
$V10O_1$	93	.961	1648 ft^3	19.3 ft^3	20.9
*$V10O_2$	103	.965	1941 ft^3	9.4 ft^3	14.8
BF_1	93	.967	8269 fbm	95.3 fbm	20.8
*BF_2	103	.970	9860 fbm	46.8 fbm	13.3

*All predictors for volume at the end of the period use projected basal area ($\hat{B}_2$) as the argument for basal area (B).

[1] m=number of observations used in evaluating the predictor

r=correlation coefficient for predicted (P) and observed (O) values

$\overline{\text{OBS}}$=average observed value=$[\sum(O)]/m$

$\bar{d}$=average difference=$[\sum(P-O)]/m$

$\overline{\%d}$=average percent difference=$[(\sum((P-O)/O))/m](100)$

Schumacher and Coile (1960) used stand total volume, i.b., in cubic feet, and quadratic-mean stand d.b.h. as arguments to derive equation 21. The argument specifications used here differ slightly from those of Schumacher and Coile. But the difference is not great enough to prohibit useful estimates. Since cord volume was not actually observed, no fit statistics for equation 21 are possible in this study.

To get a rough estimate of the cord volume in pulpwood (trees with 5 inches ≤ d.b.h. < 10 inches and tops of trees with d.b.h ≥ 10 inches), let:

$(\hat{V4O}-\hat{V10O})$=VP=cubic-foot volume in pulpwood

CS=cords in sawtimber

(C5 - CS)=CP=cords in pulpwood.

Assume that:

$$(\hat{V4O}-\hat{V10O})/V4O \approx (C5-CS)/C5$$

Then,

$$CP \approx [(C5)(VP)]/V4O \qquad (22)$$

Dry Weight

To predict dry weight of wood per acre, use estimates of V4I or V10I and of wood specific gravity from Tables 29-36 in Wahlgren and Schumann (1975) as follows:

$$\hat{W4I}=(\hat{V4I})(62.4)(SGA) \qquad (23)$$

$$\hat{W10I}=(\hat{V10I})(62.4)(SGS) \qquad (24)$$

where:

$\hat{W4I}$=approximate wood dry weight, in pounds per acre, for the stand with d.b.h. ≥ 3.6 inches; top d.o.b.=3 inches; 0.2-ft stump

$\hat{W10I}$=approximate wood dry weight; in pounds per acre, for the stand with d.b.h. ≥ 9.6 inches; top d.o.b.=7 inches; 0.2-ft stump

SGA=average tree specific gravity, all d.b.h. classes, from Wahlgren and Schumann (1975)

SGS=average tree specific gravity, sawtimber classes (d.b.h. ≥ 9.0 inches), from Wahlgren and Schumann (1975)

The merchantability specifications used here differ somewhat from Wahlgren and Schumann's. But the weight estimates should be satisfactory for most purposes.

DISCUSSION

Equations 10 - 24 provide tools for evaluating a wide variety of thinning schedules and rotation lengths. Initial conditions should be: age = 20–80 years, site index = 46–95 ft, and basal area = 16–165 ft². The minimum initial age can be 15 years, but 20 is preferable since site index estimates are more precise at later ages. Also, ingrowth above merchantability thresholds has a sudden variable effect at young ages. It is possible to start predictions as early as age 9 or 10 by using information on stand density in terms of surviving trees per acre at these early ages to predict the basal area at age 15-20 (Farrar 1979). But stand volumes probably should not be estimated before age 20.

Since this system of equations is based on stands thinned from below and on a 5-year growth period, it is prudent to restrict projections to short periods—preferably 5-10 years but no more than 30 years. Single long-term projections should be avoided because they may not be as reliable as short-term projections. Forecasting production to age 80 for a thinning regime starting at age 20 and employing 5- to 10-year cutting cycles is preferable to forecasting production of an unthinned stand from age 20 to age 80.

The appendix contains tables showing current and projected basal areas and volumes for an extensive array of initial and final ages, site indices, and basal areas at the initial age. Boxed sections of the tables contain volume values for possible but improbable combinations of stand age, site index, and basal area.

Appendix tables 1-14 give TVI and TVO volume estimates; 15-28 give V4I and V4O volume estimates; 29-42 give V10I and V10O volume estimates; and 43-56 give estimates for C5 and BF. Use of the equation system is simple, because the tables are fairly comprehensive. The equations can be used to make predictions for many combinations of initial and final stand conditions not shown in the appendix.

Tables 4 and 5 give six examples illustrating use of the prediction system and associated appendix tables. Each example assumes stand conditions are: Initial age = 30 years, site index = 70; initial basal area, before cut, = 100 ft² at age 30; and rotation length = 60 years with shelterwood regeneration via a preparatory cut at age 50, seed cut at age 55, and removal cut at age 60.

Examples 1, 4, 5, and 6 assume that the first cut occurs at age 30 when 70 basal area is left, that cuts are made on a 5-year cycle, and that 70 basal area is left after each subsequent cut between ages 30 and 50. In example 2 the leave basal area is increased at each cut. The third example assumes that no cutting occurs until age 50 when shelterwood cutting begins. All values for these examples are found in the appendix tables.

For example 1 the values are obtained as follows: Enter appendix table 9 at initial basal area = 100, initial age = 30 years, final age = 30 years, and site index = 70; read 2044 ft³, i.b., and 2775 ft³, o.b. These are before-cut standing volumes at age 30.

We want to thin from below and leave 70 basal area at age 30. Enter appendix table 6 at initial basal area = 70, initial age = 30 years, final age = 30 years, and site index = 70; read 1431 ft³, i.b., and 1939 ft³, o.b. These are after-cut standing volumes at age 30. Cut values in these examples are obtained by subtraction.

To project the 70 basal area after-cut stand from age 30 to age 35, enter appendix table 6 at initial basal area = 70, initial age = 30, final age = 35, site index = 70. Read ft³, i.b., = 2057; ft³, o.b., = 2738; and basal area = 91. These are the projected values, before cut, at age 35.

We again thin to leave 70 basal area at age 35. To get after-cut stand values enter appendix table 6 at initial basal area = 70, initial age = 35, final age = 35, site index = 70; read 1588 ft³, i.b., and 2110 ft³, o.b. These are after-cut stand volumes at age 35.

We now project the 70 basal area after-cut stand from age 35 to 40 by again entering appendix table 6 at initial basal area = 70, initial age = 35, final age = 40, site index = 70. Read ft³, i.b., = 2153; ft³, o.b., = 2821; and basal area = 88. These are the projected values, before cut, at age 40.

This procedure is repeated until at age 60 we have projected values, before cut, of ft³, i.b., = 1102; ft³, o.b., = 1361; and basal area = 37 (appendix table 2). At this time we harvest the stand. Estimate total net yield by summing

Table 4.—*Illustrations of the use of the stand volume prediction system for thinned natural longleaf, site index 70*[1]

	Estimated Stand Values Per Acre								
	Before cut			After cut			Cut		
Age	B	TVI	TVO	B	TVI	TVO	B	TVI	TVO
(yrs)	(ft^2)	(ft^3)		(ft^2)	(ft^3)		(ft^2)	(ft^3)	
Example 1: 5-year cuts, constant basal area, shelterwood									
30	100	2044	2775	70	1431	1939	30	613	836
35	91	2057	2738	70	1588	2110	21	469	628
40	88	2153	2821	70	1717	2245	18	436	576
45	86	2232	2885	70	1825	2354	16	407	531
50	84	2296	2934	60	1642	2089	24	654	845
55	72	2043	2579	30	855	1059	42	1188	1520
60	37	1102	1361	0	0	0	37	1102	1361
								4869	6297
Example 2: 5-year cuts, increasing basal area, shelterwood									
30	100	2044	2775	70	1431	1939	30	613	836
35	91	2057	2738	80	1815	2414	11	242	324
40	99	2420	3174	90	2208	2893	9	212	281
45	107	2790	3614	100	2607	3375	7	183	239
50	116	3166	4057	60	1642	2089	56	1524	1968
55	72	2043	2579	30	855	1059	42	1188	1520
60	37	1102	1361	0	0	0	37	1102	1361
								5064	6529
Example 3: No cuts to age 50, shelterwood									
30	100	2044	2775	100	2044	2775	0	0	0
50	179	4897	6294	60	1642	2089	119	3255	4205
55	72	2043	2579	30	855	1059	42	1188	1520
60	37	1102	1361	0	0	0	37	1102	1361
								5545	7086

[1] For before cut and after cut estimates: B values are known or come from equation 10
TVI values come from equation 11 or equation 12
TVO values come from equation 14

Table 5.—*Example of estimated merchantable volume production for a simulated thinning regime in a natural longleaf stand, site index =70*[1]

Estimated Stand Values Per Acre									
	Before cut			After cut			Cut		
Example 4: Estimates for V4I and V4O									
Age	B	V4I	V4O	B	V4I	V4O	B	V4I	V4O
(yrs)	(ft^2)	(ft^3)		(ft^2)	(ft^3)		(ft^2)	(ft^3)	
30	100	1905	2583	70	1339	1813	30	566	770
35	91	1972	2625	70	1527	2029	21	445	596
40	88	2097	2747	70	1676	2191	18	421	556
45	86	2192	2834	70	1795	2316	16	397	518
50	84	2268	2898	60	1626	2068	24	642	830
55	72	2027	2559	30	852	1055	42	1175	1504
60	37	1099	1357	0	0	0	37	1099	1357
								4745	6131
Example 5: Estimates for V10I and V10O									
Age	B	V10I	V10O	B	V10I	V10O	B	V10I	V10O
(yrs)	(ft^2)	(ft^3)		(ft^2)	(ft^3)		(ft^2)	(ft^3)	
30	100	104	134	70	114	150	30	....	....
35	91	280	363	70	286	373	21	....	....
40	88	579	747	70	564	730	18	15	17
45	86	968	1243	70	904	1163	16	64	80
50	84	1365	1742	60	1120	1428	24	245	314
55	72	1546	1956	30	735	913	42	811	1043
60	37	992	1229	0	0	0	37	992	1229
								2127	2683
Example 6: Estimates for C5 and BF									
Age	B	C5	BF	B	C5	BF	B	C5	BF
(yrs)	(ft^2)	(cds.)	(fbm)	(ft^2)	(cds.)	(fbm)	(ft^2)	(cds.)	(fbm)
30	100	22.2	580	70	15.9	630	30	6.3	....
35	91	23.2	1620	70	18.1	1650	21	5.1	....
40	88	24.8	3440	70	19.9	3330	18	4.9	110
45	86	26.1	5850	70	21.4	5440	16	4.7	410
50	84	27.1	8360	60	19.5	6820	24	7.6	1540
55	72	24.3	9540	30	10.2	4480	42	14.1	5060
60	37	13.3	6120	0	0	0	37	13.3	6120
								56.0	13240

[1] For before cut and after cut estimates: B values are known or come from equation 10
V4I values come from equation 15
V4O values come from equation 16
V10I values come from equation 17
V10O values come from equation 18
C5 values come from equation 21
BF values come from equation 19

values in the cut columns to get 4869 ft^3, i.b., and 6297 ft^3, o.b. The other examples were derived in similar fashion.

These examples suggest that thinning reduces net total yield over a rotation. This effect seems reasonable for total cubic-foot volumes in the absence of catastrophic mortality.

A minor interpretation problem sometimes arises when sawtimber volume (V10I, V10O, and BF) growth and yield is simulated at relatively young ages under thinning regimes. The predicted volume for a relatively high projected basal area before cut can be less than the stand volume predicted for a lower basal area after cut; the difference depends on the stand age, site index, and residual basal area chosen (table 5). This anomaly apparently occurs because sawtimber volume predictions reflect the effect of sudden ingrowth in young stands. The ingrowth effect seems related to basal area, so sawtimber volume peaks at medium densities in young stands and peaks at increasingly higher densities as age and site index increase. In a thinning simulation exercise, the effect can be that at a given age less sawtimber volume is predicted for an initial basal area than is predicted for a lower residual basal area. But the difference is generally small and the problem disappears as stand age increases. The problem can be ignored by assuming that if the stand had a certain sawtimber volume predicted at a given age before cutting, it should have no more than this volume in the residual stand. This assumption was made in table 5.

The C5 estimate is cord volume in lieu of, not in addition to, BF volume. To estimate cord volume in pulpwood and sawtimber stand components, use equation 22. For example, from the before-cut volume values at age 60 for the stand in table 5: $\hat{C5} = 13.3$ cords, $VP = (1357 - 1229) = 128$ ft^3, $\widehat{V4O} = 1357$ ft^3, and $CP \approx [(13.3)(128)]/(1357) \approx 1.3$ cords. The approximate cord volume in the sawtimber component is (13.3 − 1.3) or 12.0 cords.

We can estimate a stand's dry-weight production of wood for trees with d.b.h. $\geq$ 4 inches and for trees with d.b.h. $\geq$ 10 inches. For example, assume the example stand in table 5 is located in lower Southwest Alabama and we want dry weight estimates for the before-cut stand at age 60. We can use equations 23 and 24 with volume estimates from table 5 and tree specific gravity estimates from table 29 in Wahlengren and Schumann (1975). From equation 23, $\widehat{W4I} = (1099)(62.4)(0.54) = 37{,}032$ pounds per acre and from equation 24, $\widehat{W10I} = (992)(62.4)(0.55) = 34{,}045$ pounds per acre.

The simulation possibilities with the system of equations are considerable and, particularly if one has access to a large computer, relatively easy. So, a wide variety of stand management options can be simulated. But, keep in mind that:

(a) The system is based on the first 5 years of growth from the study and is a first approximation to the growth and yield of thinned natural longleaf. Total volume predictions are the most reliable, while sawtimber volume predictions are the least reliable. Responses predicted for sawtimber may not yet completely reflect prescribed basal area conditions because many stands have grown under their prescribed conditions for only a short period and not for all or most of their life. Inclusion of additional periods as data become available may improve the predictions.

(b) Long-term projections for unthinned stands may be inaccurate. The system is based essentially on thinned stands, a 5-year growth period, and excludes long-term mortality. The net growth recorded during the relatively short growth period may not reflect the mortality that might occur during longer periods. The system probably will not reliably project estimates for unthinned stands for more than 20 to 30 years at best unless the user develops an adjustment for long-term mortality. The basal area and volume projections from present equations tend to become unrealistically large if performed for too long an unthinned period.

(c) The equations probably depict about the best performance we can expect from thinned natural longleaf stands. The total basal area and volume predictions and projections are for uniform stand conditions and essentially incorporate only the effects of mortality attributed to suppression. Also, thinning was from below with a minor amount of improvement cutting in upper crown classes, and adverse environmental effects were minimized.

Although it has limitations, the system of equations should be useful to those planning the management and harvest of natural longleaf stands. It permits estimates of current and future stand volumes and future basal areas for a considerable array of stand conditions and allows simulation of a wide variety of thinning regimes and rotation lengths of potential interest to longleaf timber-land owners.

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APPENDIX

Current and Projected Total Cubic Foot Volume and Basal Area Per Acre

Current and Projected Merchantable Cubic Foot Volume (V4I, V4O) and Total Basal Area Per Acre

Current and Projected Merchantable Cubic Foot Volume (V10I, V10O) and Total Basal Area Per Acre

Current and Projected Cord (C5) and Board Foot Int. 1/4 (BF) Volume and Total Basal Area Per Acre

TABLE 1.--CURRENT AND PROJECTED TOTAL CUBIC FOOT VOLUME AND BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX										PROJECTED BASAL AREA
		50		60		70		80		90		
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
						20 SQ. FT. INITIAL BASAL AREA						
20	20	209	328	243	363	284	409	331	465	385	533	20
	25	480	716	559	798	652	903	760	1031	885	1183	37
	30	836	1210	974	1353	1135	1535	1322	1756	1541	2017	56
	35	1242	1760	1447	1973	1687	2242	1965	2566	2290	2951	74
	40	1672	2330	1948	2616	2270	2975	2645	3409	3082	3922	93
	45	2107	2894	2455	3255	2860	3705	3332	4247	3883	4889	'10
	50	2534	3440	2953	3873	3441	4412	4009	5061	4671	5829	126
25	25	260	385	303	430	353	487	412	556	480	639	20
	30	502	720	585	807	681	917	794	1049	925	1206	33
	35	802	1128	934	1267	1089	1441	1269	1650	1478	1899	48
	40	1140	1578	1328	1775	1548	2021	1803	2317	2101	2667	63
	45	1499	2048	1746	2306	2035	2628	2371	3014	2763	3471	78
	50	1866	2521	2174	2841	2533	3239	2951	3717	3439	4282	93
	55	2231	2986	2600	3368	3030	3842	3530	4411	4113	5083	106
30	30	301	426	351	479	409	545	476	625	555	719	20
	35	518	720	603	811	703	924	819	1059	954	1220	31
	40	777	1067	906	1202	1055	1371	1230	1573	1433	1812	43
	45	1066	1447	1243	1632	1448	1861	1687	2136	1966	2462	56
	50	1373	1845	1600	2082	1864	2376	2172	2728	2531	3144	68
	55	1689	2248	1968	2539	2293	2899	2672	3330	3113	3839	81
	60	2007	2650	2338	2995	2725	3421	3175	3930	3699	4532	93
35	35	334	457	389	517	454	590	529	678	616	782	20
	40	530	718	618	812	720	927	838	1065	977	1228	29
	45	759	1019	884	1152	1030	1316	1200	1512	1398	1744	40
	50	1011	1347	1178	1523	1372	1740	1599	2000	1863	2307	50
	55	1278	1691	1490	1913	1736	2186	2022	2512	2356	2898	61
	60	1555	2041	1812	2310	2111	2641	2459	3036	2866	3503	72
	65	1835	2393	2138	2709	2491	3098	2902	3562	3382	4111	82
40	40	361	481	421	546	491	625	572	720	666	831	20
	45	540	715	629	811	733	929	854	1069	995	1234	28
	50	744	981	867	1112	1010	1273	1177	1464	1372	1690	37
	55	968	1269	1127	1438	1314	1646	1531	1893	1784	2185	46
	60	1204	1570	1403	1780	1635	2037	1905	2344	2220	2705	56
	65	1449	1879	1689	2131	1968	2439	2293	2806	2672	3239	65
	70	1699	2191	1979	2485	2306	2844	2687	3273	3131	3779	74
45	45	384	500	448	569	521	653	608	753	708	871	20
	50	548	712	638	810	744	929	867	1070	1010	1237	27
	55	732	950	853	1080	994	1237	1159	1425	1350	1646	35
	60	933	1206	1087	1370	1267	1570	1476	1808	1720	2088	43
	65	1145	1474	1334	1674	1555	1918	1811	2209	2111	2551	51
	70	1365	1749	1590	1987	1853	2277	2159	2622	2516	3028	60
	75	1589	2028	1852	2304	2158	2640	2514	3040	2929	3512	68
50	50	403	515	470	588	547	676	638	781	743	903	20
	55	554	709	646	809	753	929	877	1071	1022	1238	26
	60	723	924	842	1052	981	1208	1143	1392	1332	1610	33
	65	905	1154	1054	1314	1228	1507	1431	1737	1668	2008	41
	70	1097	1395	1278	1587	1489	1821	1735	2098	2021	2425	48
	75	1296	1643	1510	1869	1759	2144	2050	2471	2388	2855	56
	80	1499	1895	1747	2156	2035	2473	2372	2849	2763	3292	63
55	55	420	527	489	604	570	695	664	803	773	930	20
	60	560	706	652	807	760	928	886	1071	1032	1239	26
	65	715	902	833	1029	970	1183	1131	1365	1317	1578	32
	70	881	1111	1027	1267	1196	1455	1394	1678	1624	1941	39
	75	1056	1329	1231	1515	1434	1740	1671	2006	1947	2320	45
	80	1238	1555	1442	1771	1681	2034	1958	2345	2282	2711	52
60	60	434	538	505	617	589	711	686	822	800	953	20
	65	565	703	658	805	767	927	893	1071	1041	1240	25
	70	708	883	825	1009	961	1161	1120	1341	1305	1552	31
	75	861	1074	1003	1227	1169	1411	1362	1628	1587	1884	37
	80	1022	1274	1191	1454	1388	1671	1617	1929	1884	2231	43
65	65	446	547	520	628	606	725	706	839	822	972	20
	70	569	700	663	803	772	925	900	1070	1048	1240	25
	75	702	866	818	992	953	1142	1111	1320	1294	1529	30
	80	844	1042	984	1192	1146	1372	1335	1585	1556	1835	36
70	70	457	554	532	637	620	736	723	853	842	989	20
	75	572	697	667	801	777	924	905	1069	1055	1239	25
	80	697	852	812	977	946	1126	1103	1302	1285	1508	29
75	75	467	561	544	646	634	746	738	865	860	1003	20
	80	576	695	671	799	781	923	910	1068	1061	1239	24
80	80	475	566	554	653	645	755	752	875	876	1016	20

TABLE 2.--CURRENT AND PROJECTED TOTAL CUBIC FOOT VOLUME AND BASAL AREA PER ACRE
FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX										PROJECTED BASAL AREA
		50		60		70		80		90		
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
30 SQ. FT. INITIAL BASAL AREA												
20	20	313	491	365	543	426	612	496	697	578	798	30
	25	664	992	774	1106	902	1251	1051	1428	1224	1638	51
	30	1095	1590	1276	1778	1487	2016	1733	2304	2019	2647	73
	35	1566	2226	1825	2493	2126	2831	2478	3240	2887	3725	94
	40	2048	2860	2386	3210	2780	3650	3239	4180	3774	4809	113
	45	2523	3473	2939	3904	3425	4442	3990	5091	4650	5860	131
	50	2981	4054	3473	4561	4047	5195	4715	5958	5494	6860	148
25	25	390	580	455	647	530	733	617	837	719	961	30
	30	703	1015	820	1137	955	1290	1113	1475	1296	1696	47
	35	1071	1515	1248	1699	1454	1931	1695	2211	1975	2543	64
	40	1469	2043	1711	2295	1994	2611	2324	2992	2707	3443	81
	45	1878	2575	2188	2897	2549	3299	2970	3782	3461	4355	98
	50	2285	3097	2662	3488	3102	3975	3614	4560	4211	5252	113
	55	2683	3600	3126	4058	3643	4627	4244	5310	4945	6119	128
30	30	452	646	526	725	613	824	714	943	832	1085	30
	35	733	1029	854	1156	995	1315	1159	1507	1351	1734	44
	40	1054	1456	1228	1639	1430	1866	1667	2139	1942	2463	58
	45	1397	1907	1628	2148	1897	2448	2210	2808	2576	3234	73
	50	1752	2364	2041	2665	2378	3039	2771	3488	3228	4019	87
	55	2107	2817	2455	3178	2861	3626	3333	4163	3884	4793	100
	60	2458	3257	2864	3678	3337	4198	3888	4822	4530	5559	113
35	35	501	696	584	784	681	894	793	1025	924	1181	30
	40	756	1036	881	1168	1026	1332	1195	1528	1393	1761	42
	45	1040	1410	1212	1591	1412	1815	1645	2083	1917	2400	54
	50	1343	1802	1564	2035	1823	2322	2124	2667	2475	3074	67
	55	1655	2202	1928	2487	2247	2840	2618	3262	3050	3761	79
	60	1970	2600	2295	2938	2674	3356	3116	3856	3630	4447	91
	65	2282	2990	2659	3382	3099	3864	3610	4442	4207	5123	102
40	40	542	735	632	831	736	949	858	1090	999	1257	30
	45	774	1040	902	1176	1051	1343	1224	1543	1427	1780	40
	50	1029	1372	1199	1552	1397	1773	1628	2037	1897	2349	51
	55	1300	1719	1514	1945	1764	2222	2056	2554	2395	2946	62
	60	1578	2073	1839	2346	2143	2682	2497	3083	2909	3556	73
	65	1860	2427	2168	2748	2526	3142	2943	3613	3429	4168	83
	70	2142	2777	2496	3145	2908	3598	3388	4138	3948	4775	94
45	45	576	766	671	868	782	993	911	1142	1062	1318	30
	50	789	1042	919	1181	1071	1352	1248	1554	1454	1794	39
	55	1021	1340	1189	1519	1386	1738	1614	1999	1881	2307	49
	60	1265	1651	1474	1871	1717	2141	2001	2463	2331	2842	58
	65	1516	1968	1767	2231	2059	2553	2399	2937	2795	3390	68
	70	1771	2287	2064	2593	2405	2968	2802	3415	3265	3942	78
	75	2027	2603	2362	2953	2752	3380	3206	3890	3736	4491	87
50	50	605	790	705	898	821	1029	957	1185	1115	1368	30
	55	801	1043	934	1185	1088	1357	1268	1563	1477	1804	38
	60	1013	1314	1181	1491	1376	1708	1603	1966	1868	2271	47
	65	1236	1595	1440	1810	1678	2073	1955	2387	2278	2756	55
	70	1465	1882	1707	2136	1989	2447	2318	2817	2700	3253	64
	75	1698	2171	1978	2465	2305	2824	2686	3251	3129	3754	73
	80	1932	2459	2251	2792	2622	3199	3056	3684	3560	4255	81
55	55	629	810	733	923	855	1059	996	1220	1160	1410	30
	60	812	1043	946	1187	1102	1361	1284	1569	1497	1812	37
	65	1007	1290	1174	1467	1368	1663	1593	1938	1857	2240	45
	70	1212	1547	1412	1759	1645	2016	1917	2323	2233	2684	53
	75	1422	1809	1657	2057	1931	2358	2250	2716	2621	3138	61
	80	1636	2073	1906	2357	2221	2702	2588	3113	3015	3597	69
60	60	651	827	758	943	883	1084	1029	1250	1199	1446	30
	65	821	1043	957	1189	1115	1364	1299	1573	1513	1819	37
	70	1002	1270	1168	1447	1361	1660	1585	1914	1847	2213	44
	75	1191	1506	1388	1715	1617	1968	1884	2268	2195	2621	51
	80	1386	1747	1614	1988	1881	2282	2192	2630	2554	3039	58
65	65	669	841	780	961	909	1105	1059	1275	1233	1476	30
	70	829	1042	966	1189	1125	1366	1311	1576	1528	1823	36
	75	998	1253	1162	1429	1355	1641	1578	1893	1839	2189	43
	80	1173	1471	1367	1676	1593	1925	1856	2220	2163	2568	49
70	70	686	853	799	976	931	1123	1084	1297	1264	1501	30
	75	836	1041	974	1189	1135	1365	1322	1579	1540	1827	36
	80	994	1237	1158	1412	1349	1624	1572	1874	1832	2168	42
75	75	700	864	816	989	950	1139	1107	1316	1290	1524	30
	80	842	1039	981	1189	1143	1368	1331	1581	1551	1830	35
80	80	713	872	831	1000	968	1153	1128	1332	1314	1543	30

TABLE 3.--CURRENT AND PROJECTED TOTAL CUBIC FOOT VOLUME AND BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX 50		60		70		80		90		PROJECTED BASAL AREA
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B	O.B.	I.B.	O.B.	SQ. FT.
40 SQ. FT. INITIAL BASAL AREA												
20	20	418	653	487	723	567	815	661	928	770	1063	40
	25	836	1251	974	1393	1135	1576	1322	1799	1541	2054	64
	30	1327	1930	1546	2156	1802	2444	2099	2794	2446	3209	88
	35	1846	2628	2151	2943	2506	3341	2920	3822	3403	4394	110
	40	2365	3308	2755	3711	3210	4218	3741	4830	4358	5556	131
	45	2867	3952	3340	4440	3892	5052	4535	5789	5284	6663	149
	50	3344	4553	3896	5122	4540	5833	5290	6688	6164	7701	166
25	25	520	776	606	865	706	979	823	1118	959	1283	40
	30	894	1295	1042	1448	1214	1643	1414	1878	1648	2158	59
	35	1316	1866	1533	2091	1786	2376	2081	2719	2425	3127	79
	40	1758	2451	2049	2752	2387	3130	2781	3585	3241	4125	97
	45	2203	3028	2567	3405	2991	3876	3485	4442	4060	5114	115
	50	2638	3583	3074	4033	3582	4595	4174	5270	4863	6063	131
	55	3058	4109	3563	4630	4152	5279	4837	6057	5636	6978	146
30	30	602	867	702	971	818	1103	953	1261	1110	1450	40
	35	938	1323	1093	1485	1273	1688	1483	1933	1728	2224	56
	40	1307	1815	1523	2040	1775	2321	2068	2660	2410	3062	72
	45	1693	2318	1972	2609	2298	2971	2678	3407	3126	3944	88
	50	2082	2818	2425	3174	2826	3618	3293	4151	3837	4782	103
	55	2465	3303	2872	3725	3347	4248	3899	4876	4544	5619	117
	60	2838	3769	3307	4254	3853	4854	4490	5574	5231	6425	131
35	35	668	936	779	1052	907	1198	1057	1373	1232	1580	40
	40	972	1341	1133	1510	1320	1720	1538	1972	1792	2271	54
	45	1301	1773	1516	1997	1766	2277	2058	2612	2398	3009	68
	50	1642	2214	1913	2497	2230	2848	2598	3268	3027	3766	81
	55	1987	2654	2315	2995	2698	3417	3144	3924	3663	4523	95
	60	2329	3084	2714	3483	3163	3977	3685	4568	4294	5306	107
	65	2665	3500	3105	3956	3618	4519	4215	5132	4911	5988	119
40	40	723	990	842	1116	981	1273	1143	1461	1332	1683	40
	45	1000	1354	1165	1528	1357	1743	1581	2001	1842	2306	52
	50	1236	1738	1510	1962	1759	2240	2050	2572	2388	2965	64
	55	1602	2130	1867	2406	2175	2748	2534	3157	2953	3640	76
	60	1912	2522	2228	2851	2596	3257	3024	3742	3524	4316	88
	65	2221	2908	2587	3289	3015	3759	3513	4320	4093	4963	100
	70	2524	3284	2941	3716	3427	4248	3993	4885	4653	5636	110
45	45	768	1032	895	1167	1043	1333	1215	1531	1416	1766	40
	50	1022	1362	1191	1541	1388	1760	1617	2023	1884	2333	51
	55	1291	1708	1505	1932	1753	2208	2043	2538	2380	2927	62
	60	1569	2061	1828	2332	2130	2666	2482	3065	2892	3536	72
	65	1850	2414	2156	2733	2512	3125	2927	3593	3411	4146	83
	70	2131	2763	2483	3130	2893	3580	3371	4117	3928	4751	93
	75	2409	3105	2807	3518	3270	4026	3811	4631	4440	5345	103
50	50	806	1066	940	1208	1095	1382	1276	1590	1486	1834	40
	55	1041	1368	1213	1550	1413	1773	1647	2039	1919	2354	50
	60	1288	1682	1501	1906	1748	2181	2037	2509	2374	2895	59
	65	1542	2003	1797	2270	2093	2597	2433	2988	2842	3449	69
	70	1793	2324	2096	2635	2443	3015	2846	3469	3316	4005	79
	75	2057	2642	2396	2997	2792	3430	3254	3947	3791	4557	88
	80	2312	2956	2694	3353	3139	3839	3657	4419	4262	5102	97
55	55	839	1095	978	1242	1139	1423	1328	1638	1547	1891	40
	60	1057	1372	1232	1557	1435	1783	1672	2053	1948	2370	49
	65	1285	1660	1497	1884	1744	2157	2033	2483	2368	2867	58
	70	1519	1953	1770	2217	2062	2539	2403	2922	2800	3375	66
	75	1756	2246	2046	2551	2384	2922	2778	3364	3237	3885	75
	80	1994	2540	2323	2884	2707	3304	3154	3804	3675	4393	84
60	60	868	1118	1011	1271	1178	1457	1372	1678	1599	1939	40
	65	1071	1375	1248	1563	1454	1791	1694	2063	1974	2353	48
	70	1282	1640	1494	1864	1741	2137	2029	2461	2354	2843	56
	75	1499	1910	1747	2171	2036	2488	2372	2866	2764	3311	64
	80	1719	2182	2003	2480	2334	2842	2720	3274	3169	3782	72
65	65	892	1137	1040	1295	1211	1486	1411	1713	1645	1980	40
	70	1083	1377	1261	1567	1470	1797	1713	2071	1995	2394	47
	75	1280	1623	1492	1846	1738	2118	2025	2441	2360	2821	55
	80	1482	1873	1727	2131	2013	2444	2345	2817	2732	3255	62
70	70	914	1154	1065	1316	1241	1511	1446	1742	1685	2015	40
	75	1093	1378	1274	1570	1484	1802	1729	2078	2015	2402	47
	80	1278	1607	1489	1831	1735	2101	2022	2423	2356	2811	54
75	75	933	1168	1087	1333	1267	1532	1476	1768	1720	2045	40
	80	1102	1378	1284	1572	1496	1806	1744	2083	2032	2409	46
80	80	950	1181	1107	1349	1290	1551	1504	1790	1752	2072	40

TABLE 4.--CURRENT AND PROJECTED TOTAL CUBIC FOOT VOLUME AND BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX 50 I.B.	50 O.B.	60 I.B.	60 O.B.	70 I.B.	70 O.B.	80 I.B.	80 O.B.	90 I.B.	90 O.B.	PROJECTED BASAL AREA SQ. FT.
YEARS												
		50 SQ. FT. INITIAL BASAL AREA										
20	20	522	816	609	904	709	1019	826	1160	963	1328	50
	25	999	1497	1164	1667	1357	1895	1581	2151	1942	2468	77
	30	1540	2242	1794	2504	2091	2839	2436	3244	2838	3726	102
	35	2097	2988	2443	3346	2847	3798	3317	4344	3865	4994	126
	40	2644	3702	3080	4152	3593	4719	4182	5403	4873	6214	146
	45	3166	4368	3688	4907	4298	5582	5008	6396	5835	7361	165
	50	3656	4983	4260	5604	4964	6381	5784	7316	6739	8423	181
25	25	650	972	758	1083	883	1225	1029	1398	1199	1605	50
	30	1077	1563	1254	1747	1462	1981	1703	2264	1984	2601	72
	35	1543	2192	1798	2456	2095	2789	2441	3192	2844	3670	92
	40	2221	2823	2355	3168	2744	3602	3137	4125	3726	4746	112
	45	2494	3433	2906	3858	3385	4391	3945	5032	4596	5792	130
	50	2950	4011	3437	4514	4005	5141	4666	5896	5437	6789	146
	55	3384	4553	3943	5129	4595	5846	5354	6708	6238	7727	161
30	30	753	1088	877	1217	1022	1381	1191	1580	1387	1815	50
	35	1135	1607	1323	1802	1541	2048	1796	2344	2093	2696	68
	40	1545	2151	1801	2416	2098	2748	2445	3149	2649	3623	86
	45	1964	2696	2289	3032	2667	3453	3107	3968	3621	4557	102
	50	2380	3228	2773	3634	3231	4141	3764	4750	4386	5471	118
	55	2784	3737	3244	4212	3780	4803	4404	5512	5132	6351	133
	60	3173	4220	3637	4761	4308	5432	5020	6236	5849	7188	146
35	35	835	1176	973	1320	1134	1502	1322	1720	1540	1979	50
	40	1182	1637	1377	1841	1604	2096	1869	2402	2178	2765	65
	45	1547	2116	1803	2382	2101	2714	2448	3112	2852	3584	81
	50	1920	2596	2237	2925	2606	3335	3037	3826	3539	4408	95
	55	2290	3066	2669	3458	3110	3944	3623	4528	4222	5208	109
	60	2653	3520	3092	3973	3602	4535	4197	5208	4890	6004	122
	65	3005	3955	3501	4467	4080	5101	4753	5861	5539	6758	135
40	40	903	1245	1053	1401	1227	1597	1429	1831	1665	2109	50
	45	1213	1659	1420	1870	1655	2132	1928	2445	2247	2818	63
	50	1549	2086	1805	2353	2103	2684	2450	[illegible]	[illegible]	3550	77
	55	1864	2514	2195	2838	2558	3238	2981	3719	3473	4287	90
	60	2219	2935	2585	3315	3012	3785	3509	4349	4089	5014	102
	65	2547	3344	2968	3780	3458	4318	4030	[illegible]	4635	5723	114
	70	2868	3738	3341	4228	3893	4832	4536	[illegible]	5186	6408	126
45	45	960	1293	1119	1466	1304	1673	1519	1921	1770	2214	50
	50	1250	1675	1456	1891	1696	2159	1977	2473	2303	2858	62
	55	1550	2060	1806	2327	2104	2658	2452	[illegible]	2867	[illegible]	74
	60	1855	2445	2161	2765	2518	3159	2934	3630	3419	[illegible]	86
	65	2160	2826	2556	3137	2932	3654	3416	4200	3980	[illegible]	97
	70	2460	3198	2866	3620	3340	4139	3891	4759	4534	5490	108
	75	2754	3559	3209	4030	3739	4609	4356	5301	5076	6117	118
50	50	1008	1343	1175	1519	1369	1735	1595	[illegible]	1858	2300	50
	55	1275	1666	1486	1908	1731	2180	2017	2506	2350	2890	61
	60	1551	2036	1807	2305	2106	2635	2454	3029	2859	3494	72
	65	1831	2388	2133	2703	2485	[illegible]	2896	[illegible]	[illegible]	[illegible]	82
	70	2110	2735	2459	3098	2865	3544	3338	4076	3889	4704	92
	75	2387	3076	2781	3495	3240	3988	3775	4588	4399	5295	102
	80	2658	3407	3037	3863	3609	4421	4205	5087	4899	[illegible]	112
55	55	1049	1379	1222	1562	1424	1787	1659	2055	1934	2372	50
	60	1297	1635	1511	1920	1761	2197	2052	2527	2390	2916	60
	65	1552	2016	1808	2285	2107	2614	2455	3007	2861	3471	70
	70	1810	2338	2109	2651	2457	3034	2863	3490	3336	4029	79
	75	2068	2658	2410	3014	2808	3450	3272	3970	3812	4583	89
	80	2324	2972	2708	3371	3156	3860	3677	4442	4284	5124	98
60	60	1084	1409	1264	1599	1472	1831	1715	2107	1939	2432	50
	65	1316	1701	1533	1930	1786	2210	2081	2544	2425	2937	59
	70	1553	1988	1809	2267	2108	2596	2456	2988	2862	3450	68
	75	1792	2295	2088	2605	2433	2984	2835	3435	3304	3966	77
	80	2032	2591	2368	2941	2759	3369	3215	3878	3746	4479	86
65	65	1115	1434	1300	1629	1514	1867	1764	2150	2056	2484	50
	70	1332	1706	1552	1938	1808	2221	2107	2557	2455	2954	58
	75	1553	1931	1810	2251	2109	2579	2457	2971	2863	3431	67
	80	1777	2257	2071	2565	2413	2940	2811	3386	3275	3911	75
70	70	1143	1456	1331	1656	1551	1899	1807	2188	2106	2528	50
	75	1346	1709	1569	1944	1828	2229	2129	2569	2481	2968	58
	80	1554	1966	1811	2236	2110	2564	2458	2955	2864	3414	65
75	75	1167	1474	1359	1678	1584	1926	1845	2220	2150	2567	50
	80	1359	1712	1583	1949	1845	2237	2149	2578	2504	2980	57
80	80	1188	1490	1384	1698	1613	1950	1879	2249	2190	2600	50

TABLE 5.--CURRENT AND PROJECTED TOTAL CUBIC FOOT VOLUME AND BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX 50		60		70		80		90		PROJECTED BASAL AREA
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
60 SQ. FT. INITIAL BASAL AREA												
20	20	627	978	730	1094	851	1222	992	1391	1156	1593	60
	25	1156	1773	1347	1929	1570	2182	1829	2490	2131	2856	89
	30	1739	2534	2026	2830	2361	3207	2751	3665	3205	4209	116
	35	2327	3319	2712	3715	3160	4217	3682	4823	4271	5544	139
	40	2896	4058	3374	4551	3932	5171	4581	5921	5338	6815	160
	45	3433	4740	4000	5324	4660	6056	5430	6938	6327	7984	179
	50	3933	5363	4583	6031	5340	6866	6221	7871	7249	8962	195
25	25	780	1167	909	1300	1060	1471	1235	1679	1433	1906	60
	30	1253	1822	1460	2036	1701	2308	1940	2633	2310	3030	83
	35	1758	2501	2048	2801	2386	3180	2780	3635	3341	4183	105
	40	2265	3168	2633	3554	3075	4040	3583	4626	4175	5322	125
	45	2753	3803	3215	4273	3746	4862	4365	5572	5086	6413	144
	50	3231	4398	3765	4948	4387	5635	5112	6461	5956	7440	160
	55	3677	4951	4284	5576	4992	6355	5816	7290	6777	8398	175
30	30	903	1308	1052	1463	1246	1660	1429	1948	1666	2181	60
	35	1327	1883	1547	2110	1802	2397	2100	2744	2447	3155	79
	40	1772	2471	2065	2774	2406	3155	2803	3614	3266	4159	98
	45	2218	3050	2585	3429	3011	3903	3509	4473	4088	5156	116
	50	2655	3606	3093	4059	3604	4624	4200	5303	4893	6107	132
	55	3075	4133	3583	4657	4175	5309	4865	6092	5668	7018	147
	60	3476	4628	4050	5220	4719	5954	5499	6835	6407	7417	160
35	35	1003	1416	1169	1589	1361	1806	1546	2068	1848	2378	60
	40	1356	1926	1615	2164	1882	2462	2193	2822	2555	3247	77
	45	1783	2444	2078	2750	2421	3131	2821	3591	3287	4134	93
	50	2181	2955	2541	3328	2961	3793	3450	4341	4020	5012	108
	55	2572	3449	2997	3888	3492	4434	4069	5049	4741	5864	123
	60	2951	3921	3438	4424	4006	5049	4668	5797	5439	6682	136
	65	3315	4368	3862	4933	4500	5632	5244	6469	6110	7459	149
40	40	1084	1500	1263	1687	1472	1921	1715	2202	1968	2535	60
	45	1433	1957	1670	2204	1946	2512	2267	2881	2642	3318	75
	50	1792	2420	2088	2728	2433	3110	2835	3569	3303	4112	89
	55	2151	2877	2507	3246	2921	3703	3403	4251	3965	4899	103
	60	2505	3321	2919	3749	3401	4280	3963	4915	4612	5667	116
	65	2850	3748	3321	4234	3869	4836	4508	5556	5253	6407	128
	70	3183	4155	3708	4698	4321	5368	5035	6163	5866	7116	139
45	45	1152	1566	1343	1766	1564	2013	1823	2311	2124	2662	60
	50	1472	1981	1716	2235	1999	2550	2329	2927	2714	3373	73
	55	1799	2398	2097	2708	2443	3091	2846	3550	3317	4092	86
	60	2127	2811	2478	3176	2888	3627	3364	4167	3920	4805	98
	65	2450	3214	2855	3634	3326	4151	3876	4771	4516	5503	110
	70	2766	3603	3223	4076	3755	4659	4375	5356	5098	6178	121
	75	3072	3977	3580	4502	4171	5147	4860	5919	5663	6829	132
50	50	1210	1620	1409	1830	1642	2089	1914	2393	2230	2765	60
	55	1505	1993	1754	2258	2043	2579	2381	2964	2774	3417	72
	60	1806	2379	2104	2690	2451	3073	2856	3532	3328	4074	83
	65	2106	2756	2454	3117	2860	3563	3332	4096	3886	4725	94
	70	2404	3124	2801	3536	3263	4043	3802	4649	4430	5364	105
	75	2695	3481	3140	3943	3659	4510	4263	5186	4968	5985	116
	80	2979	3826	3471	4336	4044	4960	4712	5706	5491	6587	125
55	55	1259	1664	1467	1883	1709	2152	1931	2473	2320	2853	60
	60	1533	2012	1786	2277	2081	2603	2425	2993	2844	3453	71
	65	1811	2361	2110	2674	2458	3057	2865	3516	3338	4057	81
	70	2089	2707	2434	3067	2836	3508	3304	4034	3860	4665	91
	75	2364	3048	2755	3452	3210	3950	3740	4544	4358	5245	101
	80	2635	3377	3070	3828	3577	4381	4168	5042	4816	5820	111
60	60	1301	1701	1516	1927	1767	2204	2059	2535	2349	2926	60
	65	1557	2022	1814	2292	2114	2623	2463	3017	2863	3482	70
	70	1815	2345	2115	2659	2465	3043	2872	3501	3346	4041	79
	75	2074	2655	2416	3022	2816	3459	3281	3981	3823	4596	89
	80	2330	2979	2715	3380	3164	3869	3686	4453	4295	5142	98
65	65	1338	1731	1559	1964	1817	2249	2117	2588	2467	2988	60
	70	1578	2031	1838	2304	2142	2638	2496	3037	2908	3506	69
	75	1819	2330	2120	2645	2470	3029	2878	3487	3353	4026	78
	80	2061	2628	2401	2983	2798	3417	3260	3933	3798	4543	87
70	70	1371	1758	1597	1996	1861	2287	2169	2634	2527	3042	60
	75	1596	2037	1859	2314	2167	2651	2524	3053	2941	3526	68
	80	1823	2317	2124	2632	2475	3016	2883	3474	3353	4012	77
75	75	1400	1780	1631	2024	1901	2320	2215	2673	2580	3088	60
	80	1612	2042	1878	2322	2189	2662	2550	3067	2971	3544	68
80	80	1426	1799	1661	2048	1936	2349	2255	2707	2628	3123	60

TABLE 6.--CURRENT AND PROJECTED TOTAL CUBIC FOOT VOLUME AND BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX										PROJECTED BASAL AREA
		50		60		70		80		90		
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
		70 SQ. FT. INITIAL BASAL AREA										
20	20	731	1141	852	1264	993	1425	1157	1622	1348	1858	70
	25	1308	1961	1524	2183	1776	2469	2069	2817	2411	3232	101
	30	1927	2810	2245	3138	2616	3555	3048	4062	3552	4665	128
	35	2542	3627	2961	4059	3451	4607	4021	5269	4665	6056	152
	40	3128	4386	3645	4918	4247	5588	4948	6397	5766	7357	173
	45	3676	5079	4283	5704	4991	6487	5815	7432	6776	8552	191
	50	4183	5707	4874	6417	5679	7305	6617	8374	7710	9641	207
25	25	911	1363	1061	1518	1236	1717	1440	1960	1678	2248	70
	30	1435	2074	1660	2317	1935	2626	2254	3001	2627	3447	95
	35	1962	2795	2286	3129	2664	3552	3104	4064	3617	4672	117
	40	2494	3491	2906	3916	3386	4451	3946	5096	4598	5862	138
	45	3006	4146	3503	4658	4081	5300	4755	6072	5541	6989	157
	50	3490	4754	4067	5348	4738	6089	5521	6982	6433	8039	173
	55	3944	5314	4595	5984	5354	6819	6238	7822	7269	9010	188
30	30	1054	1529	1228	1710	1431	1939	1667	2216	1942	2546	70
	35	1515	2152	1765	2411	2057	2738	2397	3134	2792	3603	91
	40	1999	2777	2318	3117	2700	3544	3147	4059	3666	4570	110
	45	2458	3384	2864	3803	3337	4328	3889	4961	4531	5710	128
	50	2912	3959	3393	4456	3954	5075	4607	5820	5367	6702	144
	55	3345	4500	3898	5069	4541	5778	5291	6629	6165	7637	159
	60	3755	5003	4375	5641	5097	6434	5939	7346	6930	8511	173
35	35	1170	1656	1363	1857	1588	2110	1850	2415	2156	2778	70
	40	1586	2208	1844	2480	2153	2821	2509	3232	2924	3719	88
	45	2010	2760	2342	3104	2729	3534	3180	4051	3705	4664	105
	50	2430	3296	2831	3712	3299	4229	3844	4851	4478	5587	121
	55	2837	3809	3306	4293	3852	4895	4488	5618	5230	6472	135
	60	3229	4295	3762	4845	4383	5527	5107	6346	5951	7314	148
	65	3602	4751	4197	5364	4890	6123	5698	7033	6639	8108	161
40	40	1265	1755	1474	1973	1717	2245	2001	2573	2331	2962	70
	45	1644	2250	1915	2533	2232	2885	2600	3308	[illegible]	3809	86
	50	2027	2743	2362	3091	2752	3523	3207	4042	3737	4656	101
	55	2407	3224	2804	3635	3267	4146	3807	4760	4427	5485	115
	60	2776	3686	3235	4160	3769	4747	4392	5452	5117	6284	128
	65	3133	4126	3651	4661	4254	5321	4957	6113	5775	7048	140
	70	3476	4543	4050	5135	4719	5866	5498	6741	6406	7775	152
45	45	1344	1833	1566	2065	1825	2354	2116	2700	2478	3110	70
	50	1691	2282	1971	2573	2296	2934	2676	3367	3118	3880	84
	55	2041	2727	2378	3077	2771	3512	3229	4032	3762	4647	97
	60	2388	3162	2782	3571	3241	4077	3777	4683	4401	5399	110
	65	2726	3582	3176	4048	3701	4624	4312	5313	5024	6127	122
	70	3054	3985	3558	4506	4146	5149	4831	5919	5629	6826	134
	75	3370	4363	3927	4943	4575	5651	5331	6497	6212	7495	144
50	50	1411	1897	1644	2141	1916	2443	2232	2804	2601	3232	70
	55	1731	2306	2017	2604	2351	2973	2739	3415	3191	3937	83
	60	2053	2712	2392	3065	2787	3500	3248	4021	3784	4637	95
	65	2372	3109	2763	3516	3220	4017	3751	4617	4371	5325	106
	70	2683	3494	3127	3953	3643	4519	4245	5195	4946	5993	117
	75	2987	3865	3480	4375	4055	5003	4725	5753	5505	6638	128
	80	3260	[illegible]	3822	4779	4453	5467	5163	6288	6046	7257	138
55	55	1469	1949	1711	2203	1994	2516	2323	2891	2707	3334	70
	60	1766	2325	2057	2629	2397	3004	2793	3453	3254	3983	81
	65	2063	2698	2404	3053	2801	3489	3264	4011	3803	4627	92
	70	2358	3063	2747	3468	3201	3965	3730	4559	4346	5261	103
	75	2647	3418	3084	3872	3594	4428	4187	5093	4879	5878	113
	80	2929	3761	3413	4262	3977	4877	4634	5610	5399	6476	123
60	60	1518	1992	1769	2255	2061	2578	2402	2964	2798	3420	70
	65	1795	2340	2091	2650	2437	3030	2839	3484	3308	4021	80
	70	2072	2684	2414	3041	2813	3479	3277	4001	3819	4617	91
	75	2346	3023	2734	3425	3185	3919	3711	4509	4324	5205	101
	80	2616	3352	3048	3800	3551	4350	4138	5005	4821	5778	110
65	65	1561	2029	1819	2299	2120	2631	2470	3026	2878	3493	70
	70	1820	2352	2121	2666	2471	3051	2880	3510	3355	4052	80
	75	2079	2672	2423	3030	2823	3468	3289	3991	3832	4608	89
	80	2336	2987	2722	3388	3171	3879	3695	4464	4305	5155	98
70	70	1600	2060	1864	2337	2172	2676	2530	3079	2948	3556	70
	75	1843	2361	2147	2680	2502	3069	2915	3532	3397	4079	79
	80	2086	2660	2430	3020	2832	3459	3300	3982	3845	4598	88
75	75	1633	2086	1903	2369	2217	2714	2584	3126	3010	3610	70
	80	1863	2369	2170	2691	2529	3083	2947	3551	3433	4101	78
80	80	1663	2109	1938	2397	2258	2748	2631	3166	3066	3658	70

TABLE 7.--CURRENT AND PROJECTED TOTAL CUBIC FOOT VOLUME AND BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX										PROJECTED BASAL AREA
		50		60		70		80		90		
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B	SQ. FT.
80 SQ. FT. INITIAL BASAL AREA												
20	20	836	1303	974	1444	1135	1628	1322	1854	1541	2123	80
	25	1455	2183	1696	2430	1976	2748	2302	3135	2683	3596	112
	30	2107	3073	2454	3431	2860	3988	3332	4442	3883	5101	140
	35	2743	3917	3196	4383	3724	4973	4339	5688	5056	6538	164
	40	3344	4691	3896	5259	4540	5975	5290	6840	6164	7867	185
	45	3901	5392	4545	6054	5296	6886	6171	7888	7190	9077	203
	50	4413	6023	5141	6771	5991	7708	6980	8835	8133	10171	219
25	25	1041	1559	1213	1736	1413	1963	1646	2240	1918	2570	80
	30	1593	2320	1856	2591	2162	2936	2520	3356	2936	3854	106
	35	2159	3077	2515	3444	2931	3910	3415	4472	3979	5141	129
	40	2712	3798	3159	4259	3681	4840	4289	5542	4998	6374	150
	45	3238	4469	3772	5019	4396	5710	5122	6542	5968	7529	169
	50	3731	5086	4347	5719	5066	6512	5902	7466	6877	8536	185
	55	4190	5649	4883	6361	5689	7248	6629	8314	7724	9576	200
30	30	1204	1750	1403	1956	1635	2217	1905	2534	2220	2911	80
	35	1699	2416	1979	2706	2306	3073	2687	3516	3131	4042	102
	40	2199	3073	2562	3448	2985	3920	3478	4489	4052	5164	122
	45	2687	3702	3131	4160	3648	4734	4251	5425	4953	6244	140
	50	3155	4293	3676	4830	4283	5501	4991	6308	5815	7264	156
	55	3598	4843	4192	5455	4884	6217	5591	7133	6631	8217	171
	60	4014	5352	4677	6034	5449	6881	6349	7898	7398	9102	185
35	35	1337	1896	1558	2125	1815	2414	2115	2763	2464	3177	80
	40	1783	2486	2077	2791	2420	3174	2820	3636	3286	4183	99
	45	2230	3066	2599	3447	3028	3924	3528	4498	4111	5178	116
	50	2668	3624	3108	4079	3622	4647	4220	5329	4917	6137	132
	55	3089	4151	3599	4678	4194	5333	4886	6119	5693	7050	147
	60	3490	4647	4067	5241	4738	5978	5521	6863	6433	7909	161
	65	3870	5110	4510	5768	5254	6583	6122	7560	7134	8715	174
40	40	1446	2010	1684	2258	1963	2569	2287	2944	2664	3388	80
	45	1851	2538	2157	2856	2513	3252	2928	3728	3412	4293	96
	50	2256	3057	2628	3443	3063	3924	3568	4501	4158	5165	112
	55	2652	3557	3090	4010	3601	4573	4195	5349	4888	6048	126
	60	3035	4034	3536	4551	4120	5193	4801	5963	5594	6873	140
	65	3402	4484	3964	5064	4618	5781	5381	6640	6270	7656	153
	70	3751	4908	4371	5547	5093	6335	5934	7279	6914	8395	164
45	45	1536	2100	1790	2365	2086	2694	2430	3090	2832	3558	80
	50	1907	2579	2223	2906	2590	3313	3017	3801	3516	4379	95
	55	2277	3047	2653	3437	3091	3921	3602	4501	4197	5187	109
	60	2639	3501	3075	3952	3583	4510	4175	5180	4864	5971	122
	65	2990	3935	3484	4445	4059	5076	4730	5831	5511	6724	134
	70	3328	4347	3877	4915	4518	5615	5264	6453	6134	7442	146
	75	3651	4738	4254	5360	4957	6126	5776	7042	6730	8124	156
50	50	1613	2174	1879	2452	2190	2796	2551	3209	2973	3698	80
	55	1955	2610	2278	2946	2654	3361	3092	3860	3603	4449	93
	60	2295	3037	2674	3431	3115	3917	3630	4499	4230	5187	106
	65	2628	3452	3062	3901	3568	4456	4157	5120	4844	5905	118
	70	2952	3850	3440	4354	4008	4976	4670	5719	5441	6597	129
	75	3265	4230	3804	4787	4433	5473	5165	6293	6018	7260	140
	80	3566	4593	4155	5200	4841	5947	5641	6840	6572	7893	150
55	55	1678	2234	1956	2523	2279	2881	2655	3309	3094	3815	80
	60	1995	2634	2325	2977	2709	3401	3156	3907	3678	4506	92
	65	2310	3027	2691	3423	3136	3912	3654	4496	4258	5186	104
	70	2619	3408	3051	3857	3555	4409	4142	5068	4827	5847	115
	75	2919	3776	3402	4275	3964	4889	4618	5622	5381	6487	125
	80	3211	4129	3741	4677	4359	5350	5079	6154	5918	7103	135
60	60	1735	2284	2022	2583	2356	2952	2745	3393	3198	3913	80
	65	2030	2654	2366	3003	2756	3433	3212	3947	3742	4553	91
	70	2323	3017	2707	3416	3154	3906	3675	4491	4282	5182	102
	75	2611	3370	3042	3817	3544	4367	4130	5022	4812	5796	112
	80	2891	3712	3369	4206	3925	4813	4574	5537	5329	6391	122
65	65	1785	2326	2079	2634	2423	3012	2823	3464	3289	3997	80
	70	2061	2670	2401	3024	2798	3460	3260	3979	3798	4593	90
	75	2334	3007	2720	3408	3169	3900	3693	4486	4303	5178	100
	80	2604	3336	3034	3782	3535	4329	4118	4981	4799	5751	110
70	70	1828	2362	2130	2677	2482	3064	2892	3525	3369	4069	80
	75	2087	2683	2432	3042	2834	3482	3302	4007	3847	4626	89
	80	2344	2998	2732	3401	3183	3893	3709	4481	4321	5174	99
75	75	1867	2393	2175	2715	2534	3109	2953	3578	3440	4132	80
	80	2111	2693	2460	3057	2866	3501	3339	4030	3691	4654	89
80	80	1901	2419	2215	2747	2581	3148	3007	3625	3504	4187	80

TABLE 8.--CURRENT AND PROJECTED TOTAL CUBIC FOOT VOLUME AND BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

90 SQ. FT. INITIAL BASAL AREA

INITIAL AGE	FINAL AGE	SITE INDEX 50		60		70		80		90		PROJECTED BASAL AREA
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
20	20	940	1406	1096	1624	1277	1832	1488	2085	1733	2389	90
	25	1599	2399	1963	2671	2171	3020	2540	3445	2948	3952	123
	30	2279	3326	2655	3713	3094	4206	3604	4806	4200	5518	151
	35	2934	4191	3419	4689	3984	5321	4642	6080	5408	6994	176
	40	3547	4978	4133	5580	4815	6339	5611	7257	6537	8345	196
	45	4111	[illegible]	4790	6381	5581	7257	6503	8314	7577	9566	214
	50	4625	6215	5389	7099	6280	8081	7317	9263	8525	10664	229
25	25	1171	1755	1364	1954	1589	2209	1852	2521	2159	2892	90
	30	1757	2561	2047	2860	2385	3241	2779	3773	3239	4253	117
	35	2348	3349	2736	3749	3189	4254	3714	4867	4328	5594	141
	40	2919	4090	3401	4587	3962	5212	4617	5967	5380	6863	162
	45	3457	4774	4028	5361	4693	6098	5468	6986	6371	8040	180
	50	3958	5397	4611	6069	5373	6909	6260	7921	7234	9119	196
	55	4421	5963	5151	6713	6002	7648	6993	8773	8148	10104	211
30	30	1355	1971	1579	2202	1839	2495	2143	2853	2497	3277	90
	35	1879	2675	2190	2996	2551	3401	2973	3891	3464	4473	112
	40	2402	3360	2798	3769	3261	4284	3799	4906	4427	5643	133
	45	2907	4008	3387	4503	3946	5123	4598	5870	5357	6756	151
	50	3386	4611	3945	5187	4597	5907	5356	6772	6241	7798	168
	55	3837	5168	4470	5820	5209	6632	6069	7608	7071	8764	183
	60	4257	5680	4961	6403	5780	7301	6735	8380	7847	9656	196
35	35	1504	2136	1752	2393	2042	2718	2379	3110	2772	3576	90
	40	1976	2759	2303	3097	2683	3521	3166	4033	3643	4640	109
	45	2444	3364	2848	3781	3318	4303	3866	4932	4505	5677	127
	50	2897	3939	3376	4433	3933	5049	4563	5790	5346	6667	144
	55	3329	4478	3879	5045	4520	5751	5267	6598	6177	7601	159
	60	3738	4961	4356	5617	5075	6406	5914	7354	6891	8475	172
	65	4124	5448	4805	6149	5598	7017	6523	8058	[illegible]	9289	185
40	40	[illegible]	2265	[illegible]	2544	2208	2893	2573	[illegible]	2997	3814	90
	45	2055	2823	2395	3174	2790	3614	3251	4143	3788	4770	107
	50	2479	[illegible]	2888	3787	3365	4315	3921	4949	4569	5700	123
	55	2893	3880	3366	4373	3923	4985	4570	[illegible]	5325	6592	138
	60	3283	4368	3825	4927	4457	5621	5183	6453	6051	7437	151
	65	3658	4826	4262	5448	4966	6219	5786	7142	6741	8234	164
	70	4013	5254	4675	5936	5447	6780	6347	7789	7396	8982	176
45	45	1728	2368	2014	2664	2346	3034	2734	3479	3186	4006	90
	50	2121	2872	2471	3235	2879	3687	3355	4230	3909	4872	105
	55	2507	3361	2921	3789	3404	4322	3966	4960	4621	5716	120
	60	2883	3829	3359	4321	3914	4931	4560	5662	5313	6526	133
	65	3244	4274	3780	4827	4404	5511	5132	6330	5979	7299	145
	70	3590	4694	4182	5305	4873	6060	5678	6963	[illegible]	9031	157
	75	3913	5090	4566	5756	5320	6578	6193	7561	7222	8723	168
50	50	1815	2451	2114	2762	2463	3150	2870	3615	3344	4164	90
	55	2176	[illegible]	2535	3283	2954	3745	3442	4300	4011	4956	104
	60	2531	3356	2950	3789	3437	4325	4004	4967	4666	5726	117
	65	2877	3784	3353	4276	3906	4883	4552	5510	5303	6469	129
	70	3211	4193	3741	4741	4359	5416	5080	[illegible]	5919	7180	141
	75	3532	[illegible]	4115	5183	4795	5924	5587	[illegible]	[illegible]	7857	151
	80	3838	4949	4472	5602	5211	6405	6071	7366	7074	8500	162
55	55	[illegible]	2519	2200	[illegible]	2564	3245	2987	3727	3480	4296	90
	60	2223	2941	2590	3322	3018	3793	3516	4357	4097	5024	102
	65	2552	3350	2974	3787	3465	4326	4037	4971	4704	5733	114
	70	2873	3745	3347	4236	3900	4841	4544	5564	[illegible]	6418	126
	75	3183	4122	3709	4665	4321	5334	5035	6133	5866	7077	136
	80	3482	4483	4057	5076	4727	5806	5508	6677	6417	7706	147
60	60	1952	2576	2274	2912	2650	3326	3088	3822	3598	4407	90
	65	2263	2965	2637	3354	3073	3832	3581	4405	4172	5081	101
	70	2570	3344	2994	3784	3489	4325	4065	4973	4736	5737	112
	75	2869	3709	3342	4200	3894	4803	4538	5523	5287	6373	123
	80	3159	4061	3680	4600	4288	5262	4996	6053	5821	6986	133
65	65	2008	2624	2339	2969	2726	3394	3176	3902	3700	4502	90
	70	2299	2985	2679	3380	3121	3865	3637	4444	4237	5108	101
	75	2585	3337	3012	3780	3510	4324	4090	4973	4765	5740	111
	80	2865	3678	3338	4168	3890	4769	4532	5486	5281	6333	121
70	70	2057	2664	2396	3018	2792	3453	3253	3971	3791	4583	90
	75	2330	3001	2715	3402	3163	3892	3686	4478	4295	5169	100
	80	2599	3330	3028	3775	3528	4321	4111	4972	4790	5740	109
75	75	2100	2699	2447	3061	2851	3503	3322	4031	3870	4654	90
	80	2358	3015	2747	3420	3201	3915	3729	4506	4345	5203	99
80	80	2139	2729	2492	3097	2903	3547	3383	4084	3942	4716	90

TABLE 9.--CURRENT AND PROJECTED TOTAL CUBIC FOOT VOLUME AND BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX 50		60		70		80		90		PROJECTED BASAL AREA
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
100 SQ. FT. INITIAL BASAL AREA												
20	20	1045	1628	1217	1805	1419	2035	1653	2317	1926	2654	100
	25	1740	2611	2027	2906	2362	3286	2752	3749	3207	4300	134
	30	2444	3569	2848	3984	3319	4513	3867	5156	4505	5921	162
	35	3116	4453	3631	4982	4231	5652	4930	6464	5744	7429	186
	40	3739	5249	4356	5883	5076	6683	5914	7650	6891	8798	207
	45	4308	5959	5019	6689	5848	7607	6814	8714	7940	10026	224
	50	4825	6589	5621	7407	6550	8430	7632	9663	8842	11124	239
25	25	1301	1950	1516	2171	1766	2455	2058	2801	2398	3214	100
	30	1918	2797	2235	3123	2604	3539	3034	4044	3538	4644	127
	35	2532	3613	2950	4043	3437	4588	4005	5248	4686	6032	152
	40	3117	4371	3632	4901	4232	5568	4931	6375	5746	7332	173
	45	3665	5064	4270	5686	4976	6467	5798	7409	6755	8526	191
	50	4172	5691	4861	6399	5663	7285	6599	8351	7689	9614	207
	55	4628	6258	5404	7044	6296	8025	7336	9205	8548	10602	221
30	30	1505	2132	1754	2448	2044	2775	2381	3171	2775	3642	100
	35	2057	2930	2397	3281	2792	3724	3254	4260	3791	4897	123
	40	2599	3639	3028	4082	3529	4639	4112	5311	4791	6109	144
	45	3118	4302	3633	4833	4233	5498	4933	6300	5747	7250	162
	50	3607	4915	4203	5528	4897	6294	5706	7216	6648	8309	179
	55	4063	5477	4735	6167	5517	7027	6428	8061	7490	9284	194
	60	4488	5990	5229	6751	6093	7698	7099	8835	8271	10180	207
35	35	1671	2376	1947	2661	2269	3022	2643	3458	3080	3975	100
	40	2167	3029	2525	3399	2942	3864	3428	4425	3994	5090	120
	45	2653	3655	3091	4107	3602	4673	4197	5356	4890	6164	138
	50	3119	4244	3634	4775	4234	5438	4934	6235	5748	7180	155
	55	3560	4792	4148	5398	4833	6152	5632	7058	6562	8130	170
	60	3975	5300	4632	5976	5397	6815	6263	7822	7327	9014	183
	65	4364	5769	5085	6510	5925	7429	6904	8531	8044	9833	196
40	40	1807	2520	2105	2829	2453	3217	2858	3685	3330	4240	100
	45	2257	3104	2630	3489	3064	3972	3570	4552	4160	5240	118
	50	2697	3663	3142	4123	3661	4697	4266	5387	4970	6204	134
	55	3119	4193	3635	4724	4235	5385	4934	6180	5749	7119	149
	60	3522	4689	4103	5293	4781	6033	5571	6925	6491	7981	162
	65	3903	5153	4547	5816	5298	6638	6173	7623	7193	8788	175
	70	4261	5584	4965	6308	5786	7203	6741	8275	7855	9542	186
45	45	1920	2635	2238	2964	2607	3375	3038	3869	3539	4455	100
	50	2332	3162	2717	3560	3166	4057	3688	4654	4298	5360	116
	55	2733	3668	3184	4134	3710	4714	4323	5410	5037	6233	130
	60	3120	4148	3635	4680	4236	5340	4935	6131	5750	7066	144
	65	3490	4601	4066	5196	4737	5931	5520	6812	6432	7854	156
	70	3841	5027	4475	5680	5215	6488	6076	7455	7080	8597	168
	75	4174	5426	4864	6135	5667	7011	6603	8058	7694	9295	179
50	50	2016	2728	2349	3073	2737	3503	3189	4020	3716	4631	100
	55	2395	3207	2790	3617	3251	4126	3788	4736	4414	5457	114
	60	2764	3669	3220	4141	3752	4726	4372	5426	5094	6255	127
	65	3120	4108	3636	4641	4236	5299	4936	6087	5751	7019	140
	70	3462	4525	4034	5115	4700	5843	5477	6715	6381	7744	152
	75	3789	4919	4414	5564	5143	6358	5993	7309	6983	8432	162
	80	4099	5290	4777	5987	5565	6845	6485	7870	7556	9081	173
55	55	2098	2804	2445	3164	2848	3610	3319	4145	3867	4777	100
	60	2448	3244	2853	3663	3324	4182	3873	4803	4513	5537	113
	65	2790	3668	3251	4144	3788	4733	4413	5438	5142	6272	125
	70	3121	4073	3636	4605	4237	5262	4936	6048	5752	6976	137
	75	3439	4459	4006	5045	4668	5767	5439	6630	6328	7649	147
	80	3743	4825	4362	5462	5082	6246	5921	7183	6899	8288	158
60	60	2169	2868	2527	3240	2945	3700	3431	4250	3998	4901	100
	65	2495	3274	2907	3701	3387	4228	3946	4859	4598	5604	112
	70	2813	3665	3277	4146	3819	4739	4449	5447	5184	6284	123
	75	3121	4041	3636	4574	4237	5229	4937	6013	5752	6938	134
	80	3418	4400	3983	4983	4640	5699	5407	6554	6300	7564	144
65	65	2231	2921	2599	3304	3028	3776	3529	4340	4111	5006	100
	70	2535	3298	2954	3732	3442	4267	4010	4905	4673	5660	111
	75	2832	3662	3300	4146	3845	4742	4481	5453	5221	6293	121
	80	3121	4012	3637	4545	4237	5199	4937	5981	5753	6903	131
70	70	2285	2967	2662	3359	3102	3841	3615	4417	4212	5097	100
	75	2571	3318	2995	3758	3490	4299	4067	4945	4738	5707	110
	80	2850	3658	3321	4145	3869	4743	4508	5457	5253	6299	120
75	75	2333	3006	2719	3406	3168	3898	3691	4484	4300	5176	100
	80	2602	3334	3032	3780	3533	4327	4116	4979	4796	5748	110
80	80	2376	3039	2769	3447	3226	3947	3759	4542	4380	5245	100

TABLE 10.--CURRENT AND PROJECTED TOTAL CUBIC FOOT VOLUME AND BASAL AREA PER ACRE
FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX										PROJECTED BASAL AREA
		50		60		70		80		90		
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
110 SQ. FT. INITIAL BASAL AREA												
20	20	1149	1791	1339	1985	1560	2238	1818	2548	2118	2919	110
	25	1878	2818	2188	3137	2549	3547	2970	4046	3461	4641	144
	30	2605	3804	3035	4245	3536	4810	4120	5495	4801	6310	173
	35	3291	4703	3834	5262	4468	5970	5205	6827	6065	7846	197
	40	3891	5507	4559	6172	5324	7011	6203	8025	7227	9228	217
	45	4434	6218	5215	6930	6101	7937	7109	9092	8283	10461	234
	50	5012	6847	5840	7696	6805	8759	7928	10040	9238	11558	249
25	25	1431	2146	1667	2389	1943	2701	2264	3082	2637	3536	110
	30	2077	3030	2420	3383	2820	3833	3285	4379	3828	5029	138
	35	2710	3869	3158	4329	3679	4913	4287	5619	4995	6458	162
	40	3309	4641	3855	5203	4492	5912	5234	6768	6098	7783	183
	45	3864	5341	4503	5997	5246	6821	6113	7814	7122	8991	201
	50	4375	5971	5098	6713	5940	7642	6921	8760	8064	10085	217
	55	4943	6537	5643	7358	6575	8382	7661	9614	8927	11073	231
30	30	1656	2412	1929	2694	2248	3053	2620	3489	3052	4007	110
	35	2232	3182	2601	3562	3030	4043	3531	4625	4114	5316	134
	40	2792	3911	3253	4386	3790	4984	4416	5707	5146	6564	155
	45	3323	4587	3872	5152	4511	5861	5256	6715	6124	7727	173
	50	3819	5207	4450	5855	5185	6667	6042	7643	7040	8800	189
	55	4280	5771	4987	6498	5811	7404	6771	8493	7889	9782	204
	60	4707	6285	5484	7083	6390	8076	7445	9268	8675	10679	217
35	35	1838	2616	2142	2930	2495	3326	2908	3805	3388	4375	110
	40	2356	3295	2745	3697	3198	4202	3726	4812	4342	5535	130
	45	2857	3939	3329	4425	3879	5035	4519	5770	5266	6641	149
	50	3334	4540	3885	5107	4526	5815	5274	6668	6145	7678	165
	55	3783	5095	4408	5738	5136	6539	5984	7502	6972	8641	180
	60	4203	5606	4897	6320	5706	7207	6648	8272	7746	9532	194
	65	4594	6076	5353	6856	6237	7823	7268	8982	8468	10353	206
40	40	1988	2775	2316	3115	2698	3542	3144	4056	3664	4667	110
	45	2457	3391	2862	3801	3335	4325	3886	4957	4528	5706	128
	50	2910	3957	3391	4453	3951	5072	4604	5817	5364	6698	144
	55	3343	4497	3895	5066	4539	5775	5289	6625	6162	7633	159
	60	3753	5000	4373	5639	5095	6431	5935	7382	6917	8507	173
	65	4138	5467	4822	6170	5618	7042	6546	8086	7627	9322	186
	70	4500	5900	5243	6664	6109	7603	7118	8741	8294	10079	197
45	45	2112	2902	2461	3263	2868	3715	3341	4259	3893	4903	110
	50	2541	3449	2960	3883	3449	4423	4019	5073	4683	5843	126
	55	2955	3969	3443	4473	4011	5099	4674	5852	5446	6742	141
	60	3351	4459	3904	5030	4549	5738	5301	6588	6176	7592	155
	65	3728	4919	4343	5553	5061	6339	5896	7280	6870	8392	167
	70	4084	5349	4758	6043	5544	6901	6460	7928	7527	9143	179
	75	4420	5749	5150	6500	6001	7426	6932	8535	8147	9844	189
50	50	2218	3005	2584	3385	3011	3857	3508	4425	4069	5097	110
	55	2611	3502	3043	3948	3545	4502	4131	5167	4815	5954	124
	60	2992	3976	3486	4487	4062	5119	4733	5878	5515	6775	138
	65	3358	4425	3912	4997	4558	5705	5311	6553	6188	7555	151
	70	3706	4848	4316	5479	5031	6258	5862	7191	6831	8293	162
	75	4037	5246	4704	5932	5481	6779	6386	7792	7441	8988	173
	80	4351	5618	5070	6358	5907	7268	6883	8356	8020	9642	183
55	55	2308	3089	2689	3485	3133	3975	3651	4563	4254	5258	110
	60	2672	3545	3113	4002	3627	4567	4227	5245	4925	6046	123
	65	3024	3980	3524	4497	4106	5135	4784	5899	5574	6802	136
	70	3363	4394	3919	4967	4566	5675	5320	6522	6199	7522	147
	75	3687	4786	4297	5414	5006	6187	5833	7113	6797	8206	158
	80	3997	5156	4657	5835	5426	6672	6322	7672	7367	8853	168
60	60	2386	3160	2780	3568	3239	4074	3774	4679	4397	5395	110
	65	2724	3580	3174	4046	3698	4621	4309	5309	5021	6123	122
	70	3052	3982	3556	4503	4144	5146	4828	5914	5625	6822	134
	75	3368	4366	3924	4940	4573	5647	5328	6493	6208	7491	144
	80	3671	4731	4278	5356	4984	6125	5808	7044	6767	8128	155
65	65	2454	3219	2859	3639	3331	4158	3882	4778	4523	5511	110
	70	2770	3608	3227	4082	3760	4666	4381	5363	5105	6187	121
	75	3076	3982	3584	4508	4177	5154	4866	5927	5670	6838	132
	80	3372	4340	3929	4915	4578	5622	5335	6466	6216	7462	142
70	70	2514	3269	2929	3700	3412	4230	3976	4863	4633	5611	110
	75	2810	3632	3274	4113	3815	4704	4445	5409	5179	6242	120
	80	3098	3981	3609	4511	4206	5160	4900	5936	5710	6851	130
75	75	2567	3312	2990	3752	3484	4292	4060	4937	4731	5698	110
	80	2846	3652	3316	4139	3863	4736	4501	5449	5245	6289	120
80	80	2614	3350	3046	3797	3549	4346	4135	5001	4818	5774	110

TABLE 11.--CURRENT AND PROJECTED TOTAL CUBIC FOOT VOLUME AND BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX										PROJECTED BASAL AREA
		50		60		70		80		90		
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
120 SQ. FT. INITIAL BASAL AREA												
20	20	1254	1953	1461	2165	1702	2441	1983	2780	2311	3184	120
	25	2013	3022	2346	3363	2733	3803	3185	4338	3711	4976	155
	30	2760	4032	3216	4500	3748	5098	4367	5824	5088	6688	183
	35	3458	4944	4030	5531	4695	6275	5471	7176	6374	8247	207
	40	4096	5753	4772	6447	5560	7324	6479	8383	7549	9640	227
	45	4671	6465	5443	7256	6342	8251	7389	9451	8510	10875	243
	50	5190	7091	6047	7970	7046	9071	8209	10397	9555	11968	257
25	25	1561	2342	1819	2607	2119	2947	2469	3363	2877	3868	120
	30	2233	3259	2602	3638	3032	4122	3532	4709	4116	5408	148
	35	2884	4119	3360	4608	3915	5229	4562	5941	5315	6874	173
	40	3494	4902	4071	5495	4743	6244	5526	7147	6439	8213	193
	45	4056	5608	4726	6296	5506	7160	6416	8202	7475	9476	211
	50	4570	6239	5325	7013	6204	7983	7229	9151	8423	10525	227
	55	5039	6803	5871	7656	6840	8722	7970	10003	9287	11521	240
30	30	1806	2633	2105	2940	2453	3332	2858	3807	3330	4373	120
	35	2405	3430	2802	3839	3265	4357	3804	4984	4432	5729	144
	40	2980	4177	3472	4684	4046	5322	4714	6093	5493	7008	165
	45	3521	4863	4103	5462	4780	6212	5570	7117	6490	8190	183
	50	4024	5488	4689	6171	5463	7026	6305	8054	7417	9273	200
	55	4488	6054	5230	6816	6093	7765	7100	8907	8273	10253	214
	60	4916	6567	5728	7400	6674	8437	7776	9682	9061	11158	227
35	35	2005	2856	2336	3198	2722	3630	3172	4153	3696	4774	120
	40	2542	3558	2962	3991	3451	4536	4021	5134	4685	5374	141
	45	3057	4217	3562	4738	4150	5390	4836	6176	5635	7107	159
	50	3543	4827	4129	5430	4811	6183	5605	7089	6531	8163	176
	55	3998	5368	4659	6067	5428	6913	6325	7931	7369	9135	191
	60	4422	5901	5152	6651	6003	7584	6994	8705	8150	10030	204
	65	4815	6370	5610	7187	6536	8200	7616	9415	8874	10852	216
40	40	2168	3031	2526	3401	2944	3866	3430	4427	3997	5093	120
	45	2654	3656	3093	4109	3603	4676	4199	5358	4892	6167	138
	50	3120	4246	3636	4777	4236	5440	4936	6238	5751	7183	155
	55	3562	4794	4150	5400	4835	6154	5634	7061	6565	8134	170
	60	3977	5302	4634	5978	5399	6818	6291	7845	7330	9017	183
	65	4366	5771	5087	6512	5927	7432	6906	8534	8047	9837	196
	70	4729	6204	5511	7006	6421	7999	7481	9163	8717	10535	207
45	45	2304	3170	2685	3563	3129	4056	3645	4648	4247	5351	120
	50	2748	3733	3201	4202	3730	4786	4346	5489	5064	6322	136
	55	3173	4265	3697	4806	4307	5478	5019	6286	5848	7242	151
	60	3577	4764	4168	5372	4656	6128	5658	7034	6593	8107	165
	65	3959	5228	4613	5901	5375	6735	6263	7734	7297	8916	177
	70	4319	5660	5022	6393	5863	7300	6832	8387	7960	9671	189
	75	4657	6061	5426	6851	6322	7827	7366	8995	8583	10374	200
50	50	2419	3282	2819	3696	3285	4211	3827	4830	4459	5563	120
	55	2826	3794	3293	4277	3837	4876	4471	5596	5209	6447	135
	60	3217	4279	3749	4827	4368	5508	5089	6323	5930	7288	148
	65	3590	4735	4183	5347	4874	6103	5679	7010	6617	8081	161
	70	3944	5163	4595	5834	5354	6662	6238	7655	7269	8827	173
	75	4278	5563	4985	6290	5808	7186	6768	8260	7885	9527	183
	80	4594	5936	5353	6716	6237	7677	7267	8826	8468	10183	193
55	55	2518	3375	2934	3805	3418	4340	3983	4981	4640	5739	120
	60	2894	3844	3372	4337	3929	4950	4577	5683	5334	6551	133
	65	3255	4243	3793	4844	4420	5530	5150	6352	6000	7324	146
	70	3601	4709	4196	5323	4889	6080	5697	6986	6637	8057	158
	75	3930	5105	4580	5774	5336	6598	6217	7584	7244	8743	168
	80	4243	5478	4944	6199	5761	7087	6712	8148	7821	9401	179
60	60	2603	3452	3033	3897	3533	4448	4117	5108	4797	5888	120
	65	2952	3884	3440	4388	4008	5011	4670	5757	5441	6638	132
	70	3288	4295	3832	4656	4464	5548	5202	6376	6061	7354	144
	75	3611	4685	4207	5300	4902	6058	5712	6964	6655	8034	155
	80	3919	5054	4566	5721	5320	6541	6199	7522	7223	8679	165
65	65	2677	3517	3119	3974	3634	4540	4234	5216	4934	6016	120
	70	3003	3917	3499	4430	4077	5062	4750	5818	5535	6711	131
	75	3317	4239	3865	4865	4504	5562	5248	6394	6114	7377	142
	80	3619	4663	4217	5279	4914	6038	5725	6943	6671	8013	152
70	70	2742	3572	3195	4041	3723	4618	4338	5309	5054	6125	120
	75	3048	3945	3551	4465	4138	5106	4821	5871	5617	6774	131
	80	3343	4302	3895	4872	4538	5572	5288	6409	6161	7397	141
75	75	2800	3619	3262	4098	3801	4687	4429	5390	5161	6220	120
	80	3087	3968	3597	4495	4191	5143	4884	5916	5691	6828	130
80	80	2851	3660	3322	4148	3871	4746	4511	5460	5256	6303	120

TABLE 12.--CURRENT AND PROJECTED TOTAL CUBIC FOOT VOLUME AND BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX										PROJECTED BASAL AREA
		50		60		70		80		90		
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
		130 SQ. FT. INITIAL BASAL AREA										
20	20	1358	2116	1583	2345	1844	2645	2149	3011	2504	3449	130
	25	2146	3222	2501	3586	2914	4055	3395	4625	3956	5306	165
	30	2912	4254	3393	4748	3953	5378	4606	6144	5367	7055	193
	35	3630	5177	4218	5791	4915	6570	5727	7513	6673	8634	217
	40	4263	5989	4967	6712	5787	7624	6743	8726	7857	10034	236
	45	4840	6700	5640	7520	6572	8551	7657	9795	8922	11270	252
	50	5358	7323	6243	8230	7275	9367	8476	10736	9876	12358	266
25	25	1681	2538	1970	2824	2296	3194	2675	3643	3117	4179	130
	30	2387	3485	2781	3890	3241	4407	3776	5035	4400	5782	159
	35	3054	4363	3558	4881	4146	5538	4830	6734	5628	7279	183
	40	3673	5156	4279	5779	4986	6565	5810	7515	6770	8642	203
	45	4240	5864	4940	6583	5756	7487	6707	8576	7815	9868	221
	50	4756	6495	5542	7301	6457	8311	7524	9526	8767	10966	236
	55	5225	7056	6088	7942	7094	9047	8266	10375	9631	11949	249
30	30	1957	2854	2280	3187	2657	3611	3096	4126	3607	4738	130
	35	2575	3676	3001	4113	3497	4668	4074	5339	4747	6137	154
	40	3164	4438	3687	4975	4296	5653	5006	6471	5833	7443	175
	45	3714	5132	4328	5763	5042	6555	5875	7509	6846	8641	193
	50	4222	5760	4919	6477	5732	7373	6679	8452	7782	9731	209
	55	4689	6327	5463	7122	6365	8114	7417	9306	8642	10718	223
	60	5117	6837	5962	7704	6947	8783	8094	10079	9431	11613	236
35	35	2172	3096	2531	3466	2949	3934	3436	4501	4004	5173	130
	40	2726	3819	3177	4283	3701	4867	4313	5573	5025	6409	151
	45	3253	4491	3731	5044	4417	5738	5147	6574	5997	7566	169
	50	3748	5108	4367	5745	5088	6541	5928	7499	6907	8634	186
	55	4207	5672	4902	6386	5712	7277	6655	8347	7754	9614	201
	60	4633	6186	5398	6972	6290	7949	7329	9123	8539	10511	214
	65	5027	6653	5857	7505	6824	8563	7952	9831	9265	11332	225
40	40	2349	3286	2737	3686	3169	4190	3716	4798	4330	5519	130
	45	2850	3929	3321	4414	3863	5023	4508	5755	5253	6624	148
	50	3327	4529	3876	5095	4516	5802	5262	6653	6131	7660	165
	55	3775	5084	4399	5726	5125	6526	5972	7486	6959	8623	180
	60	4195	5596	4888	6308	5695	7194	6636	8256	7732	9514	193
	65	4586	6065	5344	6844	6227	7809	7255	8967	8453	10335	206
	70	4951	6497	5769	7336	6721	8376	7831	9621	9125	11093	217
45	45	2496	3437	2909	3863	3389	4396	3949	5038	4601	5799	130
	50	2953	4015	3440	4518	4009	5146	4671	5902	5442	6796	146
	55	3387	4557	3947	5134	4599	5852	5359	6714	6244	7734	161
	60	3798	5062	4426	5707	5157	6510	6008	7472	7001	8611	175
	65	4185	5529	4876	6240	5681	7121	6619	8177	7713	9426	188
	70	4547	5962	5298	6733	6173	7688	7192	8832	8380	10184	199
	75	4886	6362	5693	7191	6633	8214	7729	9439	9004	10887	209
50	50	2621	3559	3054	4007	3558	4564	4146	5235	4831	6029	130
	55	3040	4084	3542	4602	4127	5247	4808	6021	5603	6936	145
	60	3439	4578	4007	5164	4669	5890	5440	6762	6339	7793	159
	65	3818	5040	4449	5689	5183	6493	6040	7457	7037	8597	171
	70	4176	5470	4865	6180	5669	7057	6605	8108	7696	9349	183
	75	4513	5871	5258	6637	6127	7583	7139	8715	8318	10092	193
	80	4830	6244	5628	7063	6557	8073	7640	9281	8902	10738	203
55	55	2727	3660	3178	4126	3703	4704	4315	5399	5027	6221	130
	60	3114	4140	3628	4671	4228	5329	4926	6119	5740	7053	144
	65	3483	4593	4059	5186	4729	5921	5510	6800	6421	7840	156
	70	3835	5019	4468	5671	5206	6477	6066	7442	7066	8583	168
	75	4168	5418	4856	6126	5659	7000	6593	8046	7682	9261	179
	80	4483	5791	5224	6552	6066	7490	7092	8612	8263	9936	189
60	60	2820	3744	3685	4225	3828	4822	4460	5537	5197	6382	130
	65	3178	4186	3703	4728	4315	5398	5028	6201	5858	7150	142
	70	3522	4604	4104	5204	4781	5945	5571	6832	6491	7879	154
	75	3850	4999	4486	5654	5226	6462	6090	7428	7096	8568	165
	80	4161	5371	4849	6078	5650	6949	6583	7990	7670	9213	175
65	65	2900	3814	3379	4310	3937	4922	4587	5654	5345	6520	130
	70	3235	4224	3769	4776	4391	5456	5117	6271	5962	7232	142
	75	3556	4613	4143	5218	4827	5965	5625	6857	6554	7911	152
	80	3863	4980	4501	5638	5244	6447	6110	7413	7119	8554	163
70	70	2971	3874	3461	4382	4033	5007	4699	5755	5475	6639	130
	75	3284	4255	3826	4816	4458	5505	5195	6330	6053	7303	141
	80	3585	4618	4178	5229	4868	5980	5672	6878	6608	7937	151
75	75	3033	3926	3534	4444	4118	5081	4738	5843	5591	6742	130
	80	3328	4282	3878	4850	4518	5547	5264	6380	6134	7364	140
80	80	3089	3970	3599	4498	4194	5146	4887	5919	5694	6832	130

TABLE 13.--CURRENT AND PROJECTED TOTAL CUBIC FOOT VOLUME AND BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

140 SQ. FT. INITIAL BASAL AREA

INITIAL AGE	FINAL AGE	SITE INDEX 50		60		70		80		90		PROJECTED BASAL AREA
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
20	20	1463	2278	1704	2525	1986	2848	2314	3243	2696	3714	140
	25	2277	3420	2654	3806	3092	4303	3603	4908	4198	5630	175
	30	3059	4470	3564	4989	4153	5651	4839	6456	5638	7413	203
	35	3777	5402	4401	6042	5128	6855	5975	7839	6961	9008	226
	40	4424	6216	5154	6966	6000	7912	6998	9056	8154	10414	245
	45	5003	6926	5829	7773	6792	8839	7913	10124	9220	11648	261
	50	5520	7545	6431	8479	7494	9650	8731	11060	10174	12731	274
25	25	1821	2733	2122	3042	2472	3440	2881	3924	3357	4501	140
	30	2539	3708	2959	4139	3447	4689	4017	5356	4680	6151	169
	35	3219	4601	3751	5147	4371	5840	5093	6679	5934	7676	193
	40	3847	5402	4482	6054	5223	6877	6085	7872	7090	9053	213
	45	4418	6112	5148	6861	5998	7803	6989	8338	8144	10284	230
	50	4936	6742	5751	7578	6701	8626	7808	9887	9098	11381	245
	55	5404	7300	6297	8215	7337	9358	8549	10732	9961	12359	258
30	30	2108	3075	2456	3433	2861	3890	3334	4444	3865	5103	140
	35	2744	3918	3198	4385	3726	4975	4341	5631	5058	6540	164
	40	3345	4693	3898	5261	4542	5977	5202	6843	6166	7870	185
	45	3902	5394	4547	6055	5298	6888	6173	7891	7192	9080	203
	50	4414	6024	5143	6773	5992	7710	6982	8838	8136	10174	219
	55	4882	6590	5688	7417	6628	8450	7723	9692	8998	11162	233
	60	5310	7097	6187	7997	7209	9116	8400	10461	9787	12053	245
35	35	2339	3336	2726	3734	3176	4238	3701	4848	4312	5573	140
	40	2909	4077	3390	4571	3949	5195	4602	5947	5362	6840	161
	45	3447	4760	4016	5345	4679	6080	5452	6866	6392	8016	179
	50	3947	5382	4599	6053	5359	6891	6244	7900	7275	9095	196
	55	4410	5948	5139	6697	5988	7630	6977	8752	8123	10080	210
	60	4838	6461	5637	7282	6568	8302	7652	9527	8915	10977	223
	65	5231	6927	6095	7813	7102	8913	8275	10233	9642	11795	235
40	40	2530	3541	2948	3972	3434	4514	4002	5169	4663	5945	140
	45	3044	4199	3547	4717	4133	5367	4815	6149	5611	7077	159
	50	3530	4809	4113	5409	4792	6159	5584	7061	6506	8130	175
	55	3984	5369	4642	6045	5409	6889	6302	7903	7343	9103	190
	60	4407	5882	5135	6630	5984	7560	6972	8676	8123	9998	203
	65	4800	6351	5593	7165	6517	8175	7593	9387	8848	10819	215
	70	5165	6781	6018	7656	7012	8740	8170	10039	9520	11574	226
45	45	2688	3704	3133	4162	3650	4736	4253	5428	4955	6247	140
	50	3156	4295	3678	4833	4285	5504	4993	6311	5818	7267	157
	55	3599	4845	4194	5457	4886	6220	5694	7136	6634	8220	172
	60	4015	5354	4679	6036	5451	6884	6352	7901	7401	9105	185
	65	4405	5823	5132	6571	5980	7498	6968	8610	8119	9925	197
	70	4769	6256	5556	7065	6474	8066	7543	9265	8789	10683	209
	75	5108	6654	5952	7520	6935	8590	8080	9871	9415	11384	219
50	50	2823	3836	3289	4318	3832	4918	4465	5640	5202	6495	140
	55	3251	4372	3789	4926	4414	5615	5143	6443	5993	7422	155
	60	3658	4873	4262	5495	4967	6268	5787	7195	6743	8292	169
	65	4042	5339	4710	6026	5487	6877	6394	7897	7450	9104	181
	70	4403	5771	5130	6518	5977	7443	6964	8551	8115	9860	193
	75	4741	6172	5524	6976	6437	7970	7500	9159	8739	10563	203
	80	5059	6543	5894	7401	6868	8459	8002	9724	9324	11218	213
55	55	2937	3945	3422	4446	3988	5069	4646	5817	5414	6702	140
	60	3333	4435	3883	5003	4525	5707	5272	6552	6143	7551	154
	65	3709	4894	4322	5525	5035	6307	5867	7243	6836	8350	166
	70	4065	5323	4736	6014	5519	6869	6430	7891	7492	9100	178
	75	4401	5724	5128	6471	5975	7394	6962	8498	8111	9802	189
	80	4717	6097	5497	6898	6405	7884	7462	9064	8695	10458	199
60	60	3036	4036	3538	4554	4122	5196	4803	5966	5597	6876	140
	65	3403	4486	3965	5066	4620	5784	5384	6643	6273	7659	153
	70	3753	4910	4373	5549	5095	6338	5937	7282	6917	8398	164
	75	4085	5308	4759	6003	5546	6859	6462	7884	7525	9094	175
	80	4399	5681	5126	6429	5972	7349	6959	8449	8108	9749	185
65	65	3123	4112	3639	4645	4240	5303	4940	6092	5756	7025	140
	70	3465	4529	4037	5119	4704	5848	5481	6720	6386	7751	152
	75	3791	4923	4418	5568	5147	6363	5998	7315	6998	8438	162
	80	4102	5294	4780	5991	5569	6850	6489	7876	7561	9088	173
70	70	3199	4177	3727	4723	4343	5396	5060	6201	5896	7153	140
	75	3519	4565	4100	5164	4778	5903	5567	6786	6486	7829	151
	80	3826	4932	4457	5583	5194	6384	6051	7341	7051	8471	161
75	75	3266	4232	3806	4790	4435	5476	5167	6296	6021	7264	140
	80	3567	4595	4157	5203	4843	5950	5643	6843	6575	7897	150
80	80	3327	4280	3876	4848	4516	5545	5262	6378	6132	7361	140

TABLE 14.--CURRENT AND PROJECTED TOTAL CUBIC FOOT VOLUME AND BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX 50		60		70		80		90		PROJECTED BASAL AREA
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
					150 SQ. FT. INITIAL BASAL AREA							
20	20	1567	2441	1826	2706	2128	3051	2479	3474	2889	3979	150
	25	2407	3614	2604	4022	3267	4547	3807	5187	4436	5950	185
	30	3203	4682	3732	5224	4349	5918	5067	6760	5904	7762	213
	35	3929	5620	4578	6286	5334	7131	6215	8155	7241	9371	235
	40	4579	6436	5335	7211	6217	8191	7243	9375	8440	10780	253
	45	5158	7143	6010	8016	7003	9115	8160	10440	9508	12011	269
	50	5674	7757	6611	8717	7703	9921	8976	11370	10458	13068	281
25	25	1951	2829	2274	3260	2649	3686	3087	4205	3596	4823	150
	30	2689	3928	3134	4384	3651	4967	4254	5674	4957	6515	179
	35	3382	4835	3941	5408	4592	6136	5350	7017	6234	8064	202
	40	4016	5641	4680	6322	5453	7182	6353	8220	7403	9453	222
	45	4591	6353	5349	7131	6233	8109	7262	9288	8462	10687	239
	50	5109	6980	5953	7846	6936	8930	8082	10235	9417	11782	253
	55	5576	7534	6497	8478	7571	9657	8821	11075	10278	12754	266
30	30	2258	3296	2631	3679	3066	4168	3572	4762	4162	5469	150
	35	2912	4159	3392	4653	3953	5280	4606	6033	5366	6940	174
	40	3523	4944	4105	5542	4783	6296	5573	7207	6433	8289	195
	45	4066	5650	4761	6343	5547	7214	6463	8264	7531	9509	213
	50	4600	6281	5360	7061	6246	8037	7277	9213	8479	10606	228
	55	5069	6844	5907	7703	6882	8775	8019	10065	9343	11591	242
	60	5496	7348	6404	8279	7462	9438	8694	10830	10130	12477	253
35	35	2506	3576	2920	4003	3403	4542	3965	5246	4620	5972	150
	40	3090	4333	3600	4858	4195	5520	4988	6319	5636	7267	171
	45	3637	5024	4237	5642	4937	6417	5752	7352	6703	8460	189
	50	4142	5651	4827	6354	5624	7234	6553	8292	7635	9547	205
	55	4608	6217	5369	6999	6256	7974	7290	9146	8494	10534	220
	60	5036	6729	5868	7582	6837	8645	7967	9920	9283	11430	232
	65	5429	7191	6326	8111	7371	9252	8588	10622	10007	12243	243
40	40	2710	3796	3158	4257	3680	4838	4288	5540	4935	6372	150
	45	3237	4467	3771	5017	4394	5708	5120	6540	5965	7526	169
	50	3730	5084	4346	5718	5064	6510	5900	7464	6875	8593	185
	55	4189	5648	4881	6359	5687	7245	6627	8311	7721	9573	200
	60	4615	6161	5377	6944	6265	7918	7300	9097	8506	10470	213
	65	5009	6629	5836	7478	6890	8532	7923	9796	9231	11290	225
	70	5373	7056	6260	7966	7294	9093	8499	10444	9903	12042	235
45	45	2880	3972	3356	4462	3911	5077	4557	5817	5309	6695	150
	50	3359	4573	3913	5145	4560	5858	5313	6717	6190	7734	167
	55	3808	5130	4437	5777	5170	6583	6024	7552	7019	8699	182
	60	4229	5641	4927	6359	5741	7252	6689	8323	7794	9591	195
	65	4620	6111	5383	6895	6273	7867	7309	9033	8516	10412	207
	70	4985	6542	5808	7387	6768	8434	7865	9687	9148	11169	218
	75	5324	6938	6203	7840	7228	8955	8422	10250	9813	11867	228
50	50	3024	4114	3524	4629	4106	5272	4784	6045	5574	6961	150
	55	3482	4659	4034	5248	4700	5981	5476	6862	6381	7905	165
	60	3875	5165	4515	5823	5260	6641	6129	7623	7142	8785	179
	65	4262	5633	4966	6357	5787	7254	6742	8330	7856	9602	191
	70	4625	6065	5389	6850	6279	7822	7316	8985	8525	10360	202
	75	4964	6465	5784	7307	6740	8347	7853	9592	9150	11063	213
	80	5282	6834	6154	7729	7171	8833	8355	10154	9735	11714	222
55	55	3147	4230	3667	4767	4273	5434	4978	6235	5801	7183	150
	60	3550	4728	4137	5332	4820	6082	5616	6982	6544	8046	164
	65	3932	5192	4581	5860	5338	6688	6220	7681	7247	8855	176
	70	4291	5623	5000	6352	5826	7254	6788	8333	7909	9609	188
	75	4629	6024	5394	6810	6285	7780	7323	8941	8532	10313	198
	80	4947	6397	5764	7236	6716	8270	7825	9507	9117	10968	208
60	60	3253	4328	3791	4882	4417	5570	5146	6395	5996	7370	150
	65	3627	4785	4226	5402	4924	6167	5738	7083	6685	8165	163
	70	3982	5213	4639	5890	5405	6727	6298	7729	7339	8913	174
	75	4317	5613	5030	6346	5860	7251	6828	8334	7956	9613	185
	80	4633	5987	5398	6773	6290	7742	7328	8901	8539	10269	195
65	65	3346	4410	3899	4980	4543	5685	5293	6530	6167	7529	150
	70	3694	4833	4304	5461	5015	6238	5844	7168	6809	8266	162
	75	4025	5230	4690	5914	5465	6758	6367	7768	7419	8961	173
	80	4339	5603	5056	6340	5891	7248	6864	8333	7997	9614	183
70	70	3428	4479	3994	5064	4653	5784	5422	6647	6318	7667	150
	75	3753	4872	4373	5511	5096	6299	5937	7241	6918	8353	161
	80	4064	5243	4735	5934	5517	6785	6428	7801	7490	9002	171
75	75	3500	4539	4078	5136	4751	5870	5536	6749	6451	7786	150
	80	3806	4906	4434	5554	5167	6351	6020	7303	7015	8427	160
80	80	3564	4591	4153	5198	4839	5945	5638	6837	6570	7890	150

Current and Projected Merchantable Cubic Foot Volume (V4I, V4O) and Total Basal Area Per Acre

TABLE 15.--CURRENT AND PROJECTED MERCHANTABLE CUBIC FOOT VOLUME(V41,V40) AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX										PROJECTED BASAL AREA
		50		60		70		80		90		
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
		20 SQ. FT. INITIAL BASAL AREA										
20	20	68	103	144	211	215	309	281	394	346	478	20
	25	289	422	450	639	583	807	711	964	847	1132	37
	30	619	887	862	1194	1066	1442	1274	1692	1503	1968	56
	35	1020	1435	1339	1822	1621	2154	1919	2507	2254	2906	74
	40	1455	2021	1846	2477	2209	2896	2603	3354	3049	3881	93
	45	1905	2610	2361	3129	2805	3634	3294	4199	3853	4853	110
	50	2349	3183	2868	3761	3391	4349	3975	5018	4644	5796	126
25	25	170	250	253	358	321	443	389	525	461	615	20
	30	396	565	529	730	647	871	769	1017	905	1181	33
	35	684	959	876	1187	1053	1393	1243	1618	1458	1873	48
	40	1018	1406	1269	1696	1512	1975	1778	2285	2081	2642	63
	45	1377	1879	1689	2230	2000	2583	2347	2983	2743	3447	78
	50	1748	2360	2119	2770	2500	3198	2923	3689	3421	4261	93
	55	2121	2835	2549	3302	2999	3804	3509	4385	4096	5063	106
30	30	257	364	327	447	394	526	465	611	546	708	20
	35	463	644	575	773	685	901	806	1043	944	1207	31
	40	714	979	874	1161	1036	1345	1215	1555	1421	1797	43
	45	998	1353	1209	1588	1427	1835	1672	2118	1954	2447	56
	50	1303	1749	1566	2038	1844	2350	2159	2710	2519	3130	68
	55	1619	2155	1935	2497	2273	2874	2658	3313	3102	3826	81
	60	1939	2559	2306	2954	2705	3397	3161	3914	3688	4519	93
35	35	313	429	378	502	446	580	523	671	611	776	20
	40	502	680	603	793	710	915	831	1056	971	1221	29
	45	724	973	866	1130	1019	1302	1192	1502	1392	1736	40
	50	972	1295	1158	1499	1360	1725	1590	1989	1856	2298	50
	55	1237	1636	1469	1887	1723	2170	2013	2501	2349	2889	61
	60	1512	1995	1791	2284	2098	2625	2450	3025	2858	3494	72
	65	1792	2337	2117	2684	2478	3083	2893	3552	3374	4102	82
40	40	351	463	415	539	486	620	568	716	663	828	20
	45	525	696	621	801	727	922	850	1063	991	1229	28
	50	725	956	857	1099	1003	1265	1172	1458	1367	1685	37
	55	945	1239	1116	1424	1306	1637	1525	1887	1779	2180	46
	60	1179	1538	1391	1754	1627	2027	1899	2337	2215	2700	56
	65	1423	1845	1676	2115	1959	2429	2287	2739	2667	3234	65
	70	1671	2156	1966	2468	2298	2834	2681	3266	3126	3773	74
45	45	379	493	444	565	519	651	606	751	706	869	20
	50	539	702	633	804	740	925	864	1067	1007	1234	27
	55	721	936	847	1072	930	1232	1155	1421	1347	1643	35
	60	919	1188	1090	1361	1262	1554	1472	1803	1717	2084	43
	65	1129	1454	1326	1664	1549	1912	1807	2204	2107	2547	51
	70	1348	1728	1582	1977	1847	2270	2155	2617	2512	3024	60
	75	1571	2006	1843	2293	2152	2633	2510	3035	2926	3508	68
50	50	400	511	469	586	546	675	637	779	742	902	20
	55	550	703	643	805	751	926	875	1069	1020	1237	26
	60	716	916	838	1049	979	1205	1141	1390	1330	1607	33
	65	893	1144	1049	1308	1225	1503	1429	1734	1665	2005	41
	70	1087	1363	1272	1581	1485	1817	1732	2095	2019	2422	48
	75	1224	1629	1504	1862	1755	2140	2047	2467	2386	2852	56
	80	1487	1880	1741	2148	2031	2468	2369	2846	2761	3290	63
55	55	418	525	488	603	569	694	663	802	773	929	20
	60	557	703	651	805	759	926	885	1070	1031	1238	26
	65	711	897	830	1026	969	1181	1129	1363	1316	1577	32
	70	876	1104	1024	1263	1194	1452	1392	1676	1623	1939	39
	75	1050	1322	1227	1511	1432	1737	1669	2004	1945	2318	45
	80	1230	1546	1438	1767	1678	2031	1956	2343	2280	2709	52
60	60	433	537	505	616	588	711	686	822	799	952	20
	65	563	701	657	803	766	926	892	1070	1040	1239	25
	70	705	880	823	1007	960	1160	1119	1340	1304	1551	31
	75	858	1070	1001	1224	1168	1409	1361	1627	1586	1883	37
	80	1018	1269	1189	1451	1386	1669	1616	1927	1883	2230	43
65	65	445	546	519	627	605	724	705	838	822	972	20
	70	568	699	662	802	772	925	899	1069	1048	1239	25
	75	700	864	817	991	952	1141	1110	1319	1293	1528	30
	80	842	1040	982	1191	1145	1371	1334	1584	1555	1834	36
70	70	457	554	532	637	620	736	723	852	842	989	20
	75	572	697	666	800	777	924	905	1069	1055	1239	25
	80	696	851	811	976	946	1125	1102	1301	1284	1508	29
75	75	466	560	543	645	633	746	738	865	860	1003	20
	80	575	694	670	799	781	922	910	1068	1061	1238	24
80	80	475	566	554	653	645	755	752	875	876	1016	20

TABLE 16.--CURRENT AND PROJECTED MERCHANTABLE CUBIC FOOT VOLUME(V41,V40) AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX 50		60		70		80		90		PROJECTED BASAL AREA
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
30 SQ. FT. INITIAL BASAL AREA												
20	20	107	161	221	323	327	467	424	594	522	719	30
	25	387	565	615	873	802	1110	990	1331	1169	1565	51
	30	791	1134	1119	1553	1392	1884	1666	2215	1967	2579	73
	35	1264	1782	1677	2287	2038	2713	2416	3160	2839	3665	94
	40	1764	2452	2252	3027	2701	3546	3185	4110	3732	4755	113
	45	2264	3108	2820	3743	3355	4352	3942	5031	4612	5814	131
	50	2749	3731	3358	4422	3985	5117	4673	5905	5461	6821	148
25	25	240	352	370	524	476	658	579	785	689	921	30
	30	531	760	730	1011	900	1215	1074	1424	1266	1656	47
	35	890	1252	1159	1576	1401	1859	1657	2162	1945	2505	64
	40	1289	1787	1626	2179	1943	2544	2288	2946	2679	3408	81
	45	1706	2335	2108	2790	2502	3238	2937	3741	3435	4323	98
	50	2125	2877	2589	3392	3059	3920	3584	4522	4188	5223	113
	55	2537	3400	3060	3971	3603	4578	4217	5277	4924	6093	128
30	30	362	516	479	660	584	785	693	916	816	1063	30
	35	631	884	803	1087	964	1274	1137	1478	1333	1711	44
	40	946	1305	1175	1569	1398	1825	1644	2111	1924	2441	58
	45	1289	1755	1576	2080	1865	2408	2188	2780	2558	3213	73
	50	1645	2219	1991	2600	2348	3002	2750	3462	3212	3999	87
	55	2006	2680	2408	3117	2833	3591	3314	4139	3868	4779	100
	60	2363	3130	2820	3622	3311	4166	3870	4800	4516	5542	113
35	35	450	625	558	749	664	872	781	1010	914	1168	30
	40	696	954	851	1129	1007	1308	1182	1511	1382	1747	42
	45	975	1321	1180	1549	1392	1790	1631	2065	1905	2386	54
	50	1275	1711	1532	1993	1803	2297	2110	2649	2463	3060	67
	55	1587	2111	1896	2446	2227	2816	2604	3245	3039	3748	79
	60	1904	2512	2264	2899	2655	3333	3102	3840	3620	4435	91
	65	2219	2907	2630	3345	3081	3843	3598	4427	4197	5112	102
40	40	512	695	616	811	726	936	850	1081	993	1249	30
	45	738	992	883	1153	1039	1329	1216	1533	1420	1771	40
	50	989	1318	1179	1526	1385	1757	1619	2026	1890	2340	51
	55	1256	1662	1493	1918	1751	2206	2046	2543	2388	2937	62
	60	1534	2015	1818	2319	2130	2666	2487	3071	2901	3547	73
	65	1816	2370	2147	2722	2513	3126	2933	3602	3421	4160	83
	70	2099	2721	2475	3120	2895	3583	3379	4127	3941	4767	94
45	45	558	742	662	856	776	985	906	1136	1058	1313	30
	50	767	1013	908	1167	1064	1342	1242	1548	1449	1788	39
	55	995	1307	1176	1503	1377	1727	1608	1991	1876	2301	49
	60	1236	1615	1459	1854	1708	2130	1994	2455	2326	2836	58
	65	1487	1931	1752	2213	2049	2542	2392	2930	2789	3384	68
	70	1741	2249	2049	2575	2396	2957	2796	3407	3260	3936	78
	75	1997	2565	2347	2935	2743	3370	3200	3882	3731	4485	87
50	50	594	776	698	890	817	1024	953	1181	1112	1365	30
	55	787	1025	926	1175	1083	1351	1264	1558	1474	1801	38
	60	996	1292	1172	1480	1370	1701	1599	1961	1864	2266	47
	65	1217	1571	1430	1799	1672	2066	1950	2382	2274	2752	55
	70	1445	1856	1697	2124	1983	2439	2313	2812	2696	3249	64
	75	1677	2145	1968	2452	2298	2816	2681	3245	3125	3750	73
	80	1910	2433	2240	2780	2616	3192	3051	3678	3556	4251	81
55	55	622	801	729	918	852	1055	993	1218	1158	1408	30
	60	802	1032	941	1181	1099	1357	1282	1565	1494	1810	37
	65	996	1276	1168	1460	1363	1678	1590	1935	1854	2237	45
	70	1199	1531	1405	1751	1641	2011	1913	2319	2231	2680	53
	75	1408	1792	1650	2048	1926	2352	2246	2712	2618	3135	61
	80	1621	2055	1899	2348	2216	2697	2584	3109	3012	3594	69
60	60	646	821	755	940	881	1081	1028	1248	1198	1444	30
	65	815	1035	953	1184	1112	1361	1297	1571	1512	1817	37
	70	994	1261	1163	1442	1358	1657	1583	1912	1845	2211	44
	75	1182	1495	1383	1709	1614	1964	1882	2265	2193	2619	51
	80	1375	1735	1609	1982	1878	2278	2189	2627	2552	3037	58
65	65	666	837	778	959	907	1103	1057	1274	1232	1474	30
	70	824	1037	963	1186	1123	1364	1310	1575	1526	1822	36
	75	992	1246	1159	1425	1352	1639	1577	1891	1837	2187	43
	80	1167	1463	1364	1672	1591	1923	1854	2218	2161	2566	49
70	70	683	851	797	974	930	1122	1083	1296	1263	1501	30
	75	832	1037	972	1187	1133	1366	1321	1578	1539	1826	36
	80	990	1232	1156	1410	1348	1622	1571	1873	1831	2167	42
75	75	698	862	814	988	949	1138	1107	1315	1289	1523	30
	80	839	1037	979	1187	1142	1367	1331	1580	1551	1829	35
80	80	712	871	830	999	967	1152	1127	1332	1313	1543	30

TABLE 17.--CURRENT AND PROJECTED MERCHANTABLE CUBIC FOOT VOLUME(V41,V40) AND
TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX 50		60		70		80		90		PROJECTED BASAL AREA
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
40 SQ. FT. INITIAL BASAL AREA												
20	20	147	219	299	435	439	626	568	794	697	960	40
	25	479	698	769	1091	1006	1390	1232	1673	1470	1968	64
	30	944	1353	1348	1872	1682	2279	2016	2682	2381	3124	89
	35	1475	2081	1970	2689	2399	3196	2846	3725	3345	4320	110
	40	2023	2814	2594	3491	3116	4094	3676	4746	4308	5493	131
	45	2561	3518	3200	4251	3810	4946	4478	5718	5240	6609	149
	50	3074	4176	3774	4981	4469	5743	5241	6628	6126	7655	166
25	25	310	454	465	690	631	873	770	1045	917	1227	40
	30	658	942	919	1275	1139	1541	1362	1809	1607	2105	59
	35	1075	1514	1415	1928	1716	2281	2032	2655	2387	3078	79
	40	1527	2120	1939	2603	2322	3045	2736	3528	3206	4081	97
	45	1988	2725	2467	3271	2932	3800	3444	4391	4029	5075	115
	50	2442	3311	2985	3915	3529	4528	4137	5225	4835	6035	131
	55	2881	3867	3483	4527	4105	5220	4805	6018	5611	6948	146
30	30	463	663	630	870	773	1042	921	1220	1085	1418	40
	35	789	1107	1019	1383	1228	1628	1452	1892	1703	2192	56
	40	1156	1600	1451	1942	1731	2264	2037	2621	2386	3032	72
	45	1546	2113	1903	2517	2257	2919	2649	3371	3097	3896	88
	50	1943	2626	2361	3090	2788	3570	3266	4118	3816	4756	103
	55	2336	3128	2813	3648	3312	4205	3875	4846	4525	5596	117
	60	2719	3609	3253	4185	3822	4815	4468	5547	5214	6404	131
35	35	581	812	735	993	880	1162	1038	1348	1216	1560	40
	40	878	1210	1086	1448	1291	1683	1517	1947	1776	2251	54
	45	1204	1639	1469	1936	1738	2241	2038	2587	2332	2990	68
	50	1547	2084	1868	2438	2202	2813	2579	3245	3012	3748	81
	55	1895	2529	2272	2940	2672	3386	3125	3902	3648	4506	95
	60	2242	2967	2674	3432	3139	3947	3668	4548	4280	5251	107
	65	2583	3392	3067	3909	3595	4492	4200	5174	4899	5974	119
40	40	668	914	814	1080	964	1251	1131	1445	1322	1670	40
	45	939	1271	1135	1489	1339	1720	1568	1984	1832	2293	52
	50	1232	1653	1479	1923	1740	2216	2036	2556	2377	2952	64
	55	1538	2045	1836	2368	2156	2725	2521	3141	2942	3627	76
	60	1849	2439	2198	2814	2578	3235	3012	3727	3514	4304	88
	65	2160	2828	2559	3254	2998	3738	3501	4306	4083	4972	100
	70	2467	3209	2915	3683	3411	4229	3982	4871	4644	5625	110
45	45	733	985	877	1144	1031	1318	1206	1521	1409	1758	40
	50	982	1309	1171	1515	1375	1745	1608	2012	1877	2324	51
	55	1249	1652	1484	1906	1740	2192	2033	2527	2373	2919	62
	60	1525	2004	1807	2306	2117	2650	2473	3054	2895	3527	72
	65	1807	2357	2135	2707	2499	3110	2918	3583	3403	4138	83
	70	2068	2708	2463	3105	2881	3565	3363	4107	3921	4743	93
	75	2367	3052	2787	3495	3259	4012	3802	4621	4433	5337	103
50	50	783	1036	927	1193	1087	1372	1270	1582	1481	1828	40
	55	1014	1333	1199	1533	1405	1763	1640	2032	1913	2347	50
	60	1259	1645	1486	1888	1739	2170	2031	2501	2368	2889	59
	65	1511	1963	1782	2251	2084	2586	2432	2980	2837	3442	69
	70	1768	2284	2081	2616	2433	3004	2839	3461	3311	3998	79
	75	2026	2603	2382	2979	2783	3420	3247	3940	3786	4551	88
	80	2282	2917	2680	3336	3130	3829	3651	4411	4257	5096	97
55	55	823	1074	969	1232	1134	1416	1323	1633	1543	1887	40
	60	1038	1348	1222	1545	1429	1776	1667	2047	1944	2365	49
	65	1264	1634	1487	1871	1738	2149	2028	2477	2364	2863	58
	70	1497	1926	1759	2204	2055	2531	2398	2916	2796	3370	66
	75	1734	2219	2035	2538	2377	2914	2773	3358	3233	3880	75
	80	1971	2512	2312	2871	2700	3296	3149	3798	3671	4389	84
60	60	856	1104	1005	1263	1174	1452	1369	1675	1596	1936	40
	65	1057	1358	1241	1554	1449	1786	1690	2059	1971	2380	48
	70	1268	1622	1487	1855	1736	2131	2025	2456	2361	2839	56
	75	1483	1891	1739	2161	2030	2482	2368	2862	2760	3307	64
	80	1703	2161	1995	2470	2329	2836	2716	3269	3166	3778	72
65	65	884	1127	1035	1290	1208	1482	1409	1710	1643	1977	40
	70	1073	1365	1256	1560	1466	1793	1710	2068	1993	2391	47
	75	1269	1610	1486	1840	1734	2114	2022	2437	2357	2818	55
	80	1471	1859	1721	2124	2009	2440	2342	2813	2730	3252	62
70	70	908	1147	1062	1312	1239	1508	1444	1740	1683	2013	40
	75	1086	1369	1270	1565	1481	1799	1727	2075	2013	2400	47
	80	1270	1597	1485	1826	1733	2098	2020	2420	2354	2799	54
75	75	929	1163	1085	1330	1265	1530	1475	1766	1719	2044	40
	80	1097	1372	1281	1568	1494	1803	1742	2081	2030	2408	46
80	80	947	1177	1105	1346	1289	1549	1502	1789	1751	2071	40

TABLE 18.--CURRENT AND PROJECTED MERCHANTABLE CUBIC FOOT VOLUME(V41,V40) AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX 50		60		70		80		90		PROJECTED BASAL AREA
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
50 SQ. FT. INITIAL BASAL AREA												
20	20	186	278	376	547	551	784	711	994	873	1201	50
	25	566	825	915	1298	1200	1662	1471	1999	1756	2352	77
	30	1084	1554	1559	2165	1948	2642	2337	3111	2762	3625	102
	35	1653	2348	2232	3049	2722	3629	3231	4231	3799	4908	126
	40	2251	3133	2906	3899	3481	4576	4108	5307	4816	6142	146
	45	2818	3875	3529	4692	4405	5462	4944	6316	5786	7300	165
	50	3353	4558	4124	5423	4885	6260	5730	7248	6698	8372	181
25	25	380	555	603	855	786	1087	960	1304	1145	1532	50
	30	779	1116	1100	1527	1368	1852	1638	2177	1933	2535	72
	35	1247	1758	1653	2254	2009	2673	2381	3114	2798	3610	92
	40	1742	2422	2224	2988	2667	3500	3144	4057	3684	4694	112
	45	2239	3073	2788	3701	3317	4302	3897	4973	4559	5747	130
	50	2721	3693	3333	4377	3944	5064	4624	5844	5405	6750	146
	55	3181	4274	3852	5010	4542	5779	5317	6663	6210	7693	161
30	30	564	807	779	1079	962	1300	1148	1524	1354	1772	50
	35	939	1321	1226	1668	1483	1970	1755	2291	2061	2655	68
	40	1352	1875	1709	2291	2043	2677	2406	3100	2819	3586	86
	45	1781	2439	2203	2919	2616	3388	3072	3914	3593	4523	102
	50	2210	2933	2695	3532	3165	4083	3733	4711	4361	5441	118
	55	2630	3526	3174	4121	3739	4751	4376	5477	5109	6324	133
	60	3033	4031	3634	4580	4271	5386	4994	6205	5829	7164	146
35	35	710	996	911	1235	1096	1451	1295	1685	1519	1952	50
	40	1052	1454	1314	1757	1566	2047	1843	2368	2157	2739	65
	45	1419	1938	1742	2302	2064	2667	2422	3080	2832	3560	81
	50	1797	2427	2170	2850	2572	3292	3013	3797	3520	4385	95
	55	2175	2909	2616	3389	3078	3905	3601	4501	4204	5198	109
	60	2546	3376	3043	3911	3573	4499	4177	5184	4875	5985	122
	65	2906	3823	3456	4411	4053	5069	4735	5839	5524	6741	135
40	40	820	1129	1012	1347	1201	1564	1411	1809	1651	2091	50
	45	1132	1540	1378	1815	1629	2099	1910	2423	2232	2800	63
	50	1462	1968	1764	2299	2078	2653	2432	3059	2841	3533	77
	55	1800	2400	2156	2787	2534	3209	2964	3699	3460	4271	90
	60	2138	2827	2548	3268	2990	3758	3494	4330	4077	4999	102
	65	2471	3244	2933	3736	3438	4293	4015	4945	4684	5709	114
	70	2796	3645	3309	4188	3874	4809	4523	5539	5275	6395	126
45	45	904	1223	1091	1430	1295	1651	1506	1906	1760	2202	50
	50	1190	1595	1427	1854	1679	2137	1964	2464	2293	2846	62
	55	1490	1979	1777	2291	2087	2636	2439	3038	2847	3509	74
	60	1796	2367	2133	2729	2501	3138	2922	3615	3409	4175	86
	65	2102	2751	2489	3164	2916	3634	3405	4187	3971	4835	97
	70	2405	3127	2841	3588	3324	4120	3880	4746	4526	5481	108
	75	2702	3491	3185	4000	3724	4592	4346	5289	5068	6108	118
50	50	969	1292	1155	1494	1356	1720	1586	1984	1851	2291	50
	55	1234	1631	1465	1882	1719	2164	2008	2495	2343	2881	61
	60	1508	1981	1787	2279	2093	2619	2444	3018	2852	3486	72
	65	1788	2332	2113	2678	2473	3076	2887	3544	3367	4093	82
	70	2068	2681	2439	3074	2853	3529	3329	4066	3882	4696	92
	75	2346	3024	2762	3462	3229	3974	3767	4578	4392	5288	102
	80	2619	3358	3079	3841	3598	4408	4197	5078	4893	5865	112
55	55	1022	1343	1208	1545	1415	1776	1653	2048	1928	2365	50
	60	1267	1656	1496	1902	1751	2185	2045	2519	2385	2909	60
	65	1521	1976	1793	2266	2098	2603	2448	2999	2855	3465	70
	70	1779	2298	2094	2632	2448	3022	2857	3482	3331	4023	79
	75	2037	2618	2395	2996	2799	3439	3265	3962	3807	4577	89
	80	2294	2933	2694	3353	3147	3849	3670	4435	4279	5123	98
60	60	1064	1384	1253	1586	1466	1823	1710	2101	1995	2428	50
	65	1294	1673	1522	1917	1779	2202	2076	2538	2421	2932	59
	70	1530	1969	1798	2253	2101	2588	2451	2982	2858	3445	68
	75	1769	2266	2077	2591	2426	2975	2830	3428	3299	3961	77
	80	2009	2561	2357	2927	2752	3360	3210	3873	3742	4475	86
65	65	1101	1416	1292	1620	1509	1861	1760	2146	2053	2480	50
	70	1316	1686	1544	1928	1803	2214	2103	2553	2452	2950	58
	75	1536	1960	1801	2241	2103	2573	2453	2966	2860	3428	67
	80	1759	2235	2062	2554	2407	2933	2807	3381	3272	3907	75
70	70	1131	1442	1325	1649	1547	1894	1804	2184	2103	2525	50
	75	1334	1694	1562	1936	1823	2225	2126	2565	2479	2965	58
	80	1541	1950	1804	2228	2105	2559	2455	2951	2861	3411	65
75	75	1158	1464	1355	1673	1581	1923	1843	2218	2148	2564	50
	80	1349	1700	1578	1943	1841	2233	2147	2575	2502	2978	57
80	80	1181	1482	1381	1694	1611	1947	1878	2247	2188	2598	50

TABLE 19.--CURRENT AND PROJECTED MERCHANTABLE CUBIC FOOT VOLUME(V41,V40) AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX										PROJECTED BASAL AREA
		50		60		70		80		90		
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
60 SQ. FT. INITIAL BASAL AREA												
20	20	226	336	454	659	663	943	855	1194	1048	1442	60
	25	650	947	1055	1497	1387	1921	1700	2311	2031	2721	89
	30	1215	1742	1755	2439	2197	2980	2637	3512	3117	4093	116
	35	1836	2592	2472	3370	3018	4026	3584	4696	4215	5448	139
	40	2456	3421	3168	4263	3812	5012	4499	5914	5274	6730	160
	45	3048	4193	3824	5086	4559	5923	5361	6850	6274	7918	179
	50	3600	4897	4433	5832	5253	6755	6162	7798	7204	9007	195
25	25	449	655	719	1020	940	1302	1151	1563	1373	1838	60
	30	895	1283	1275	1770	1589	2153	1904	2533	2249	2951	83
	35	1408	1997	1877	2562	2285	3044	2710	3547	3185	4113	105
	40	1942	2701	2497	3345	2993	3922	3522	4547	4128	5262	125
	45	2468	3390	3081	4093	3659	4761	4311	5504	5045	6361	144
	50	2973	4038	3648	4793	4319	5548	5065	6403	5920	7396	160
	55	3449	4639	4182	5443	4933	6220	5776	7241	6746	8360	175
30	30	664	951	929	1287	1151	1557	1376	1827	1624	2127	60
	35	1084	1527	1427	1944	1731	2301	2050	2679	2408	3105	79
	40	1539	2136	1954	2623	2340	3068	2757	3555	3231	4113	98
	45	2001	2744	2484	3294	2952	3826	3468	4422	4057	5110	116
	50	2457	3331	3003	3940	3551	4557	4163	5258	4865	6073	132
	55	2897	3889	3503	4552	4128	5250	4832	6052	5643	6988	147
	60	3317	4412	3979	5128	4678	5902	5470	6800	6385	7851	160
35	35	838	1178	1087	1477	1312	1740	1551	2023	1821	2344	60
	40	1221	1691	1536	2057	1834	2401	2159	2779	2529	3215	77
	45	1524	2222	2003	2651	2377	3075	2790	3552	3262	4105	93
	50	2032	2749	2473	3238	2921	3741	3422	4316	3998	4985	108
	55	2424	3261	2934	3807	3455	4388	4043	5058	4721	5840	123
	60	2825	3751	3381	4351	3973	5007	4645	5769	5421	6660	136
	65	3200	4216	3811	4858	4470	5595	5223	6444	6094	7440	149
40	40	971	1341	1208	1614	1439	1878	1691	2172	1980	2512	60
	45	1320	1800	1616	2133	1913	2470	2244	2852	2624	3296	75
	50	1682	2269	2036	2661	2402	3071	2813	3543	3286	4092	89
	55	2047	2735	2458	3183	2892	3667	3383	4227	3949	4881	103
	60	2407	3189	2874	3692	3375	4247	3944	4893	4603	5650	116
	65	2759	3627	3279	4182	3845	4806	4491	5536	5239	6391	128
	70	3099	4045	3670	4651	4298	5341	5019	6151	5854	7102	139
45	45	1074	1458	1304	1716	1541	1984	1806	2290	2110	2646	60
	50	1393	1873	1678	2185	1976	2521	2313	2907	2701	3358	73
	55	1721	2293	2060	2661	2421	3064	2831	3531	3304	4078	86
	60	2052	2711	2443	3132	2866	3602	3350	4149	3908	4791	98
	65	2379	3120	2822	3592	3307	4128	3862	4754	4505	5490	110
	70	2699	3516	3192	4038	3737	4637	4362	5341	5088	6167	121
	75	3010	3896	3551	4467	4154	5127	4848	5905	5653	6819	132
50	50	1154	1545	1382	1795	1626	2068	1901	2385	2220	2754	60
	55	1448	1923	1726	2224	2027	2559	2369	2949	2764	3406	72
	60	1749	2304	2077	2656	2435	3054	2845	3518	3319	4063	83
	65	2051	2683	2428	3085	2644	3544	3321	4083	3873	4715	94
	70	2351	3055	2776	3505	3248	4025	3792	4636	4422	5354	105
	75	2645	3416	3117	3914	3645	4493	4253	5175	4960	5976	116
	80	2931	3766	3449	4309	4031	4945	4703	5696	5483	6578	125
55	55	1218	1611	1447	1858	1697	2136	1982	2462	2313	2844	60
	60	1491	1957	1766	2252	2069	2588	2416	2982	2818	3444	71
	65	1769	2307	2090	2649	2446	3043	2856	3505	3331	4048	81
	70	2048	2654	2414	3042	2824	3493	3296	4024	3843	4648	91
	75	2324	2995	2736	3429	3198	3936	3732	4535	4351	5238	101
	80	2596	3328	3052	3806	3566	4369	4160	5033	4850	5813	111
60	60	1271	1662	1501	1908	1757	2193	2052	2527	2393	2919	60
	65	1526	1982	1799	2273	2104	2611	2456	3009	2864	3476	70
	70	1784	2305	2100	2640	2455	3031	2865	3493	3340	4035	79
	75	2042	2625	2401	3004	2806	3448	3274	3973	3817	4590	89
	80	2299	2940	2700	3362	3155	3859	3680	4446	4290	5136	98
65	65	1316	1703	1548	1950	1810	2240	2112	2582	2463	2983	60
	70	1554	2001	1826	2290	2134	2630	2490	3030	2903	3501	69
	75	1795	2300	2108	2630	2462	3020	2872	3480	3349	4021	78
	80	2037	2597	2390	2969	2791	3408	3255	3927	3794	4538	87
70	70	1354	1736	1589	1996	1856	2281	2165	2629	2524	3038	60
	75	1578	2014	1850	2303	2161	2645	2520	3048	2938	3523	68
	80	1804	2294	2114	2621	2469	3009	2879	3469	3356	4009	77
75	75	1386	1763	1624	2015	1896	2315	2211	2669	2577	3085	60
	80	1598	2024	1871	2313	2184	2657	2547	3063	2968	3540	68
80	80	1415	1786	1656	2041	1932	2345	2253	2704	2626	3126	60

TABLE 20.--CURRENT AND PROJECTED MERCHANTABLE CUBIC FOOT VOLUME(V41,V40) AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

70 SQ. FT. INITIAL BASAL AREA

INITIAL AGE	FINAL AGE	SITE INDEX 50		60		70		80		90		PROJECTED BASAL AREA
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
20	20	265	394	531	771	775	1101	998	1394	1223	1683	70
	25	731	1054	1191	1689	1567	2171	1922	2613	2297	3077	101
	30	1339	1920	1940	2609	2433	3301	2921	3891	3454	4536	128
	35	1997	2820	2695	3686	3254	4305	3913	5128	4602	5950	152
	40	2645	3686	3419	4607	4115	5413	4838	6281	5696	7270	173
	45	3258	4483	4092	5446	4880	6344	5740	7337	6718	8480	191
	50	3823	5203	4713	6202	5595	7186	6554	8295	7661	9591	207
25	25	518	756	836	1185	1095	1516	1341	1822	1601	2144	70
	30	1009	1446	1445	2007	1804	2446	2164	2879	2556	3355	95
	35	1562	2205	2081	2856	2548	3396	3024	3959	3555	4593	117
	40	2129	2953	2735	3680	3253	4318	3877	5007	4544	5795	138
	45	2681	3685	3354	4457	3905	5137	4696	5997	5495	6932	157
	50	3204	4355	3938	5177	4664	5994	5470	6318	6394	7991	173
	55	3694	4970	4484	5838	5230	6737	6194	7768	7235	8963	188
30	30	764	1094	1078	1495	1339	1813	1603	2131	1893	2481	70
	35	1226	1728	1624	2214	1972	2625	2338	3057	2747	3545	91
	40	1716	2335	2189	2941	2624	3444	3094	3992	3625	4619	110
	45	2228	3031	2749	3548	3270	4241	3842	4902	4495	5665	128
	50	2687	3647	3291	4321	3994	4999	4566	5769	5336	6663	144
	55	3145	4225	3808	4952	4469	5712	5255	6585	6138	7603	159
	60	3577	4762	4296	5539	5051	6377	5908	7347	6896	8482	173
35	35	965	1358	1262	1717	1527	2029	1808	2360	2123	2735	70
	40	1386	1922	1753	2351	2097	2747	2470	3182	2893	3681	88
	45	1821	2495	2254	2987	2677	3467	3144	4006	3677	4630	105
	50	2255	3055	2751	3606	3252	4169	3811	4810	4453	5556	121
	55	2678	3592	3234	4200	3810	4842	4459	5582	5207	6445	135
	60	3085	4101	3697	4702	4346	5481	5081	6314	5931	7290	149
	65	3472	4579	4139	5291	4856	6082	5674	7005	6621	8087	161
40	40	1121	1551	1405	1879	1676	2191	1972	2536	2308	2933	70
	45	1503	2054	1849	2445	2192	2834	2573	3273	3008	3783	86
	50	1834	2559	2300	3010	2716	3476	3181	4010	3716	4632	101
	55	2282	3054	2747	3562	3234	4104	3783	4731	4417	5463	115
	60	2651	3531	3183	4093	3739	4709	4371	5426	5101	6264	128
	65	3028	3985	3603	4600	4226	5287	4937	6090	5760	7031	140
	70	3380	4417	4007	5081	4693	5836	5481	6721	6393	7759	152
45	45	1242	1692	1517	2001	1795	2316	2105	2674	2461	3090	70
	50	1591	2145	1924	2511	2268	2898	2656	3343	3102	3861	84
	55	1945	2597	2334	3020	2745	3478	3210	4009	3748	4629	97
	60	2297	3041	2740	3518	3217	4046	3759	4662	4387	5383	110
	65	2641	3470	3137	3999	3678	4596	4296	5294	5012	6112	122
	70	2973	3882	3523	4462	4125	5124	4816	5901	5617	6813	134
	75	3297	4274	3894	4903	4556	5628	5317	6481	6201	7483	144
50	50	1337	1797	1609	2095	1894	2416	2217	2786	2589	3218	70
	55	1658	2208	1983	2560	2330	2947	2724	3397	3180	3923	83
	60	1932	2618	2359	3023	2767	3476	3234	4005	3773	4624	95
	65	2304	3020	2732	3476	3201	3994	3738	4601	4361	5313	106
	70	2619	3411	3097	3917	3626	4498	4233	5180	4936	5982	117
	75	2927	3787	3453	4341	4039	4983	4713	5739	5496	6628	128
	80	3224	4148	3797	4748	4438	5449	5178	6276	6038	7248	138
55	55	1414	1877	1685	2170	1978	2496	2312	2877	2698	3323	70
	60	1711	2253	2031	2597	2381	2985	2782	3439	3245	3972	81
	65	2010	2628	2379	3021	2786	3471	3253	3998	3794	4617	92
	70	2307	2997	2723	3438	3187	3948	3720	4547	4338	5251	103
	75	2598	3355	3062	3844	3580	4412	4178	5082	4871	5869	113
	80	2883	3702	3392	4236	3964	4862	4625	5600	5392	6468	123
60	60	1477	1939	1749	2230	2049	2563	2393	2953	2791	3411	70
	65	1754	2287	2072	2625	2425	3015	2831	3474	3301	4012	80
	70	2031	2632	2395	3017	2801	3465	3269	3991	3812	4610	91
	75	2307	2972	2715	3403	3174	3906	3703	4500	4318	5197	101
	80	2578	3304	3030	3779	3540	4337	4130	4996	4815	5771	110
65	65	1530	1988	1804	2280	2110	2619	2463	3018	2872	3486	70
	70	1789	2311	2106	2647	2462	3040	2873	3502	3350	4046	80
	75	2048	2632	2408	3012	2814	3457	3282	3983	3827	4602	89
	80	2305	2948	2707	3370	3162	3868	3689	4457	4300	5149	98
70	70	1575	2029	1852	2322	2164	2667	2525	3073	2944	3550	70
	75	1818	2330	2135	2665	2494	3060	2910	3526	3392	4074	79
	80	2061	2629	2418	3005	2824	3450	3294	3976	3840	4593	88
75	75	1614	2062	1893	2358	2211	2707	2579	3120	3007	3606	70
	80	1843	2345	2161	2679	2523	3076	2942	3546	3430	4097	78
80	80	1648	2090	1930	2388	2253	2743	2628	3162	3063	3654	70

TABLE 21.--CURRENT AND PROJECTED MERCHANTABLE CUBIC FOOT VOLUME(V41,V40) AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX										PROJECTED BASAL AREA
		50		60		70		80		90		
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
80 SQ. FT. INITIAL BASAL AREA												
20	20	305	452	609	883	886	1260	1142	1593	1399	1923	80
	25	809	1178	1323	1876	1742	2414	2138	2907	2555	3424	112
	30	1457	2069	2117	2945	2657	3606	3192	4253	3775	4958	140
	35	2148	3034	2907	3975	3354	4742	4222	5534	4956	6422	164
	40	2821	3932	3652	4922	4398	5787	5193	6715	6089	7772	185
	45	3451	4750	4340	5777	5178	6731	6090	7786	7128	9000	203
	50	4028	5493	4969	6542	5892	7581	6913	8751	8081	10108	219
25	25	588	857	952	1350	1250	1731	1531	2081	1829	2449	80
	30	1119	1604	1610	2238	2014	2732	2417	3217	2856	3750	106
	35	1710	2413	2296	3137	2801	3735	3326	4355	3910	5053	129
	40	2306	3211	2959	3938	3570	4693	4213	5444	4939	6300	150
	45	2880	3961	3609	4799	4301	5587	5057	6460	5917	7467	169
	50	3420	4650	4207	5533	4985	6408	5847	7397	6835	8544	185
	55	3920	5277	4762	6203	5620	7160	6581	8255	7687	9532	200
30	30	863	1237	1227	1703	1528	2070	1830	2434	2162	2835	80
	35	1364	1924	1816	2478	2209	2942	2620	3428	3079	3975	102
	40	1887	2625	2415	3248	2899	3807	3418	4413	4006	5107	122
	45	2406	3304	3002	3936	3573	4636	4199	5359	4913	6194	140
	50	2905	3945	3563	4681	4217	5417	4946	6252	5780	7221	156
	55	3377	4540	4093	5326	4827	6145	5652	7094	6601	8180	171
	60	3819	5099	4590	5922	5359	6819	6315	7857	7372	9070	185
35	35	1091	1537	1437	1958	1743	2317	2064	2697	2425	3127	80
	40	1547	2149	1966	2639	2354	3087	2774	3577	3250	4139	99
	45	2011	2758	2497	3312	2968	3847	3487	4446	4079	5138	116
	50	2469	3347	3018	3959	3569	4579	4183	5283	4889	6103	132
	55	2910	3906	3518	4572	4146	5273	4854	6079	5668	7019	147
	60	3330	4430	3995	5149	4697	5926	5492	6828	6411	7883	161
	65	3727	4918	4446	5687	5217	6538	6097	7530	7114	8692	174
40	40	1270	1760	1600	2145	1912	2504	2252	2899	2637	3354	80
	45	1683	2303	2078	2751	2466	3192	2896	3688	3386	4262	96
	50	2099	2841	2556	3349	3020	3870	3539	4465	4135	5157	112
	55	2508	3361	3024	3925	3562	4525	4168	5216	4867	6023	126
	60	2904	3857	3477	4475	4086	5150	4777	5934	5575	6850	140
	65	3283	4326	3910	4995	4587	5743	5360	6614	6253	7636	153
	70	3644	4767	4323	5486	5065	6301	5915	7256	6899	8377	164
45	45	1410	1924	1730	2285	2050	2648	2405	3058	2812	3534	80
	50	1786	2412	2166	2832	2556	3270	2994	3772	3497	4357	95
	55	2162	2892	2600	3369	3060	3882	3590	4475	4180	5167	109
	60	2533	3358	3026	3850	3554	4475	4155	5156	4849	5953	122
	65	2902	3805	3439	4389	4033	5044	4712	5810	5497	6707	134
	70	3238	4229	3877	4864	4494	5586	5247	6433	6121	7427	146
	75	3569	4621	4217	5314	4935	6100	5761	7025	6718	8111	156
50	50	1520	2047	1835	2395	2163	2763	2533	3186	2958	3680	80
	55	1865	2489	2236	2892	2629	3330	3075	3838	3589	4432	93
	60	2209	2924	2634	3391	3092	3888	3614	4479	4217	5172	106
	65	2548	3346	3025	3855	3546	4430	4142	5102	4832	5891	118
	70	2877	3752	3406	4312	3988	4951	4656	5702	5430	6584	129
	75	3190	4141	3773	4749	4414	5451	5152	6277	6008	7248	140
	80	3502	4511	4126	5165	4824	5927	5629	6826	6563	7882	150
55	55	1609	2141	1923	2481	2259	2856	2641	3292	3082	3802	80
	60	1928	2545	2293	2937	2690	3377	3143	3891	3667	4493	92
	65	2245	2942	2661	3386	3118	3890	3641	4481	4247	5174	104
	70	2557	3329	3023	3822	3538	4388	4131	5054	4817	5837	115
	75	2862	3702	3375	4243	3948	4870	4607	5609	5372	6477	125
	80	3157	4060	3717	4647	4345	5333	5069	6142	5910	7094	135
60	60	1682	2215	1997	2552	2340	2933	2734	3380	3189	3903	80
	65	1979	2587	2341	2973	2742	3415	3201	3934	3734	4543	91
	70	2273	2952	2683	3387	3140	3889	3665	4480	4274	5173	102
	75	2563	3309	3020	3790	3531	4351	4120	5011	4804	5788	112
	80	2846	3654	3348	4181	3913	4798	4565	5527	5322	6383	122
65	65	1744	2273	2060	2610	2411	2998	2814	3454	3282	3989	80
	70	2020	2618	2382	3001	2786	3446	3251	3970	3792	4585	90
	75	2295	2957	2702	3385	3158	3886	3685	4477	4296	5171	100
	80	2566	3288	3016	3761	3524	4317	4111	4973	4793	5744	110
70	70	1796	2321	2114	2659	2472	3053	2885	3517	3364	4063	80
	75	2056	2642	2417	3024	2825	3471	3295	3999	3842	4620	89
	80	2313	2959	2717	3383	3174	3883	3702	4474	4316	5168	99
75	75	1841	2360	2162	2700	2526	3100	2947	3572	3436	4127	80
	80	2086	2651	2448	3042	2858	3492	3334	4024	3887	4649	89
80	80	1880	2393	2205	2735	2574	3140	3002	3619	3500	4182	80

TABLE 22A.--CURRENT AND PROJECTED MERCHANTABLE CUBIC FOOT VOLUME(V41,V40) AND
TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

90 SQ. FT. INITIAL BASAL AREA

INITIAL AGE	FINAL AGE	SITE INDEX 50		60		70		80		90		PROJECTED BASAL AREA
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
20	20	344	511	686	995	998	1418	1285	1793	1574	2164	90
	25	886	1290	1451	2059	1913	2651	2349	3194	2807	3762	123
	30	1570	2251	2267	3182	2872	3899	3452	4599	4082	5363	151
	35	2291	3236	3106	4249	3799	5072	4515	5913	5311	6869	176
	40	2986	4163	3871	5219	4663	6137	5507	7122	6458	8245	196
	45	3631	5000	4571	6086	5455	7093	6417	6205	7511	9485	214
	50	4218	5743	5207	6357	6175	7947	7246	9174	8471	10597	229
25	25	657	958	1068	1515	1404	1945	1722	2340	2057	2755	90
	30	1227	1759	1773	2404	2220	3011	2665	3548	3150	4136	117
	35	1852	2615	2494	3409	3945	4062	3616	4737	4252	5496	141
	40	2475	3447	3193	4301	3841	5051	4534	5260	5316	6782	162
	45	3059	4221	3850	5122	4590	5964	5330	6698	6317	7973	180
	50	3622	4927	4460	5868	5286	6798	6201	7847	7249	9063	196
	55	4132	5563	5023	6544	5928	7555	6943	8711	8110	10057	211
30	30	962	1379	1375	1910	1716	2326	2058	2738	2431	3190	90
	35	1500	2116	2004	2737	2441	3253	2897	3792	3405	4398	112
	40	2053	2837	2635	3545	3165	4158	3733	4821	4376	5579	133
	45	2595	3566	3244	4310	3853	5015	4541	5798	5313	6702	151
	50	3111	4228	3821	5023	4525	5815	5307	6711	6203	7751	168
	55	3596	4837	4363	5679	5146	6554	6026	7556	7038	8724	183
	60	4047	5394	4857	6222	5726	7234	6698	8335	7819	9622	196
35	35	1217	1716	1612	2198	1958	2606	2321	3034	2727	3518	90
	40	1706	2370	2175	2922	2608	3422	3074	3966	3602	4599	109
	45	2196	3014	2733	3628	3251	4217	3820	4874	4469	5633	127
	50	2674	3629	3274	4299	3874	4973	4542	5739	5308	6629	144
	55	3130	4206	3790	4929	4468	5665	5231	6554	6109	7568	159
	60	3562	4742	4277	5515	5030	6350	5880	7316	6666	8446	172
	65	3957	5238	4735	6060	5558	6957	6496	8025	7579	9264	185
40	40	1419	1968	1796	2410	2149	2816	2532	3262	2966	3774	90
	45	1860	2548	2304	3053	2737	3545	3214	4096	3759	4734	107
	50	2299	3115	2806	3679	3317	4253	3888	4908	4543	5668	123
	55	2726	3657	3293	4277	3879	4931	4541	5685	5302	6564	138
	60	3136	4169	3759	4842	4418	5573	5166	6421	6030	7413	151
	65	3525	4649	4203	5373	4931	6176	5762	7114	6723	8212	164
	70	3894	5098	4622	5870	5417	6742	6326	7764	7379	8963	176
45	45	1577	2156	1943	2570	2304	2980	2704	3442	3162	3978	90
	50	1978	2675	2405	3148	2840	3637	3327	4196	3888	4847	105
	55	2375	3190	2861	3711	3368	4277	3941	4930	4602	5692	120
	60	2761	3665	3304	4250	3931	4891	4538	5635	5296	6505	133
	65	3133	4126	3730	4753	4375	5475	5111	6306	5963	7280	145
	70	3489	4561	4137	5249	4847	6028	5660	6942	6602	8014	157
	75	3927	4971	4525	5706	5296	6550	6182	7542	7210	8708	168
50	50	1702	2297	2062	2694	2432	3110	2848	3587	3327	4143	90
	55	2069	2766	2486	3219	2925	3709	3421	4275	3994	4936	104
	60	2432	3222	2904	3731	3410	4292	3985	4944	4651	5709	117
	65	2785	3652	3310	4223	3931	4853	4534	5599	5290	6453	129
	70	3126	4081	3703	4692	4337	5389	5064	6205	5906	7165	141
	75	3453	4479	4080	5139	4774	5899	5572	6793	6498	7844	151
	80	3766	4833	4440	5562	5192	6383	6058	7351	7064	8488	162
55	55	1803	2405	2160	2793	2540	3216	2970	3707	3467	4280	90
	60	2142	2833	2553	3274	2995	3765	3501	4338	4085	5009	102
	65	2476	3249	2938	3743	3444	4301	4022	4954	4692	5720	114
	70	2801	3631	3314	4195	3881	4817	4530	5548	5284	6406	126
	75	3116	4037	3678	4628	4303	5313	5022	6119	5857	7065	136
	80	3420	4404	4029	5042	4710	5786	5496	6664	6408	7696	147
60	60	1887	2490	2244	2873	2632	3303	3075	3806	3587	4395	90
	65	2201	2883	2608	3317	3055	3811	3568	4390	4162	5069	101
	70	2510	3266	2967	3750	3472	4306	4053	4959	4727	5727	112
	75	2812	3637	3317	4168	3879	4784	4527	5511	5279	6364	123
	80	3106	3993	3656	4570	4274	5245	4986	6041	5813	6977	133
65	65	1957	2558	2315	2939	2711	3377	3165	3890	3692	4492	90
	70	2250	2922	2656	3351	3107	3848	3627	4433	4229	5119	101
	75	2538	3277	2990	3753	3497	4308	4080	4962	4758	5731	111
	80	2820	3621	3318	4142	3877	4754	4523	5476	5274	6325	121
70	70	2016	2613	2377	2995	2780	3439	3245	3962	3784	4576	90
	75	2291	2952	2695	3379	3152	3879	3678	4469	4288	5161	100
	80	2561	3282	3011	3754	3518	4309	4104	4964	4784	5734	109
75	75	2068	2658	2431	3042	2841	3492	3315	4023	3865	4648	90
	80	2326	2975	2732	3402	3192	3905	3723	4499	4340	5197	99
80	80	2112	2696	2479	3082	2896	3538	3377	4077	3937	4711	90

TABLE 23.--CURRENT AND PROJECTED MERCHANTABLE CUBIC FOOT VOLUME(V41,V40) AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX 50 I.B.	50 O.B.	60 I.B.	60 O.B.	70 I.B.	70 O.B.	80 I.B.	80 O.B.	90 I.B.	90 O.B.	PROJECTED BASAL AREA
YEARS												SQ. FT.
		100 SQ. FT. INITIAL BASAL AREA										
20	20	384	569	764	1107	1110	1577	1429	1993	1749	2405	100
	25	961	1399	1577	2237	2080	2882	2554	3474	3054	4092	134
	30	1680	2407	2451	3410	3080	4102	3702	4933	4379	5753	162
	35	2427	3430	3295	4509	4034	5385	4794	6286	5640	7296	186
	40	3143	4381	4078	5499	4914	6469	5804	7508	6807	8691	207
	45	3801	5234	4789	6377	5715	7433	6724	8599	7870	9940	224
	50	4336	5935	5430	7151	6440	8289	7557	9570	8835	11054	239
25	25	727	1053	1165	1680	1559	2159	1912	2599	2285	3061	100
	30	1333	1911	1932	2636	2422	3226	2908	3873	3438	4515	127
	35	1939	2809	2685	3672	3281	4378	3928	5108	4584	5926	152
	40	2637	3573	3407	4591	4101	5395	4841	6259	5677	7245	173
	45	3248	4469	4080	5429	4866	6324	5722	7314	6697	8455	191
	50	3813	5188	4700	6185	5571	7166	6536	8272	7640	9555	207
	55	4330	5833	5257	6865	6218	7926	7283	9139	8507	10552	221
30	30	1022	1522	1524	2118	1905	2583	2285	3041	2700	3544	100
	35	1633	2305	2190	2991	2670	3559	3169	4150	3726	4814	123
	40	2214	3082	2848	3834	3423	4499	4039	5218	4735	6039	144
	45	2777	3818	3477	4622	4143	5380	4870	6221	5999	7191	162
	50	3309	4498	4058	5350	4819	6195	5653	7150	6607	8259	179
	55	3804	5119	4619	6015	5450	6943	6382	8004	7454	9242	194
	60	4262	5693	5129	6623	6035	7627	7060	8787	8241	10144	207
35	35	1343	1694	1797	2438	2173	2894	2577	3372	3029	3910	100
	40	1862	2569	2391	3202	2658	3752	3370	4350	3949	5033	120
	45	2376	3263	2964	3936	3327	4577	4145	5291	4850	6115	138
	50	2872	3900	3522	4627	4160	5355	4889	6180	5714	7138	155
	55	3342	4493	4051	5270	4777	6081	5593	7010	6532	8094	170
	60	3783	5040	4547	5866	5348	6754	6255	7781	7301	8983	183
	65	4195	5543	5010	6415	5892	7376	6874	8495	8021	9806	196
40	40	1567	2176	1992	2674	2366	3129	2812	3626	3294	4195	100
	45	2035	2790	2527	3351	3004	3893	3528	4500	4128	5200	118
	50	2495	3383	3050	4002	3607	4629	4229	5341	4942	6169	134
	55	2938	3944	3553	4618	4187	5325	4901	6139	5724	7089	149
	60	3359	4470	4031	5195	4739	5930	5542	6890	6469	7954	162
	65	3758	4959	4483	5734	5261	6592	6147	7593	7173	8765	175
	70	4132	5413	4908	6233	5752	7163	6718	8248	7837	9522	186
45	45	1743	2387	2155	2854	2558	3312	3004	3826	3513	4422	100
	50	2167	2934	2641	3461	3121	4000	3658	4615	4274	5331	116
	55	2583	3452	3115	4045	3670	4664	4295	5376	5016	6207	130
	60	2983	3964	3573	4601	4199	5295	4910	6100	5731	7043	144
	65	3366	4437	4010	5125	4705	5291	5498	6786	6414	7834	156
	70	3730	4880	4426	5618	5166	6153	6056	7431	7064	8579	168
	75	4074	5295	4819	6090	5641	6979	6535	8037	7680	9279	179
50	50	1884	2546	2288	2993	2701	3457	3164	3988	3696	4606	100
	55	2271	3039	2733	3544	3217	4034	3765	4707	4395	5435	114
	60	2650	3515	3168	4074	3722	4688	4351	5401	5077	6236	127
	65	3015	3939	3788	4591	4208	5265	4916	6064	5736	7001	140
	70	3367	4400	3931	5061	4675	5913	5459	6694	6368	7728	152
	75	3702	4805	4375	5515	5121	6331	5977	7291	6971	8418	162
	80	4020	5188	4741	5943	5545	6720	6470	7854	7545	9069	173
55	55	1997	2668	2398	3104	2821	3576	3299	4121	3852	4759	100
	60	2354	3118	2809	3608	3298	4150	3855	4781	4498	5520	113
	65	2702	3551	3211	4094	3764	4704	4397	5419	5129	6256	125
	70	3039	3936	3599	4559	4215	5236	4921	6030	5740	6962	137
	75	3363	4361	3973	5003	4648	5743	5425	6613	6327	7636	147
	80	3674	4736	4330	5424	5064	6224	5909	7168	6889	8277	158
60	60	2091	2764	2491	3194	2923	3673	3416	4232	3986	4887	100
	65	2421	3177	2873	3658	3367	4203	3932	4842	4587	5590	112
	70	2744	3575	3246	4107	3800	4716	4436	5432	5174	6272	123
	75	3056	3958	3607	4538	4220	5209	4925	5999	5743	6927	134
	80	3359	4323	3955	4949	4624	5680	5396	6541	6291	7554	144
65	65	2170	2841	2571	3269	3011	3755	3517	4326	4102	4995	100
	70	2477	3222	2927	3699	3426	4247	3999	4892	4664	5649	111
	75	2778	3591	3275	4115	3830	4724	4470	5441	5212	6283	121
	80	3069	3946	3613	4516	4223	5183	4927	5969	5745	6894	131
70	70	2236	2904	2640	3331	3088	3825	3605	4406	4204	5088	100
	75	2524	3258	2974	3732	3477	4284	4057	4934	4731	5699	110
	80	2806	3601	3300	4120	3857	4729	4499	5447	5246	6291	120
75	75	2294	2956	2700	3384	3156	3884	3683	4475	4294	5169	100
	80	2565	3287	3014	3759	3522	4314	4109	4970	4790	5741	110
80	80	2344	2999	2754	3429	3217	3936	3752	4535	4374	5239	100

TABLE 24.--CURRENT AND PROJECTED MERCHANTABLE CUBIC FOOT VOLUME(V41,V40) AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

110 SQ. FT. INITIAL BASAL AREA

INITIAL AGE	FINAL AGE	SITE INDEX 50		60		70		80		90		PROJECTED BASAL AREA
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
20	20	424	627	841	1219	1222	1735	1572	2193	1925	2646	110
	25	1035	1506	1700	2411	2244	3109	2756	3748	3295	4416	144
	30	1785	2559	2609	3330	3231	4455	3944	5257	4665	6131	173
	35	2558	3614	3478	4759	4259	5626	5062	6638	5955	7704	197
	40	3291	4589	4275	5766	5153	6784	6087	7875	7138	9116	217
	45	3961	5456	4994	6651	5962	7755	7014	8971	8211	10371	234
	50	4563	6215	5639	7429	6690	8612	7830	9942	9178	11484	249
25	25	796	1159	1301	1845	1713	2373	2102	2858	2512	3366	110
	30	1438	2061	2088	2904	2610	3556	3147	4193	3722	4839	138
	35	2123	2999	2672	3927	3511	4685	4171	5467	4906	6344	162
	40	2792	3891	3614	4871	4352	5726	5138	6644	6025	7690	183
	45	3419	4707	4300	5723	5129	6368	6033	7712	7061	8915	201
	50	3995	5437	4927	6486	5842	7516	6854	8677	8013	10022	217
	55	4518	6080	5499	7169	6493	8278	7605	9545	8884	11021	231
30	30	1161	1664	1673	2325	2093	2939	2512	3345	2969	3898	110
	35	1764	2491	2373	3242	[illegible]	3931	3438	4503	4042	5224	134
	40	2371	3302	3056	4115	3675	4832	4337	5605	5085	6487	155
	45	2953	4062	3703	4924	4413	5733	5189	6630	6073	7663	173
	50	3499	4758	4306	5664	5102	6560	5985	7572	6996	8746	189
	55	4003	5389	4864	6336	5740	7314	6722	8433	7852	9737	204
	60	4406	5958	5378	[illegible]	6329	8000	7404	9218	8643	10641	217
35	35	1469	2072	1961	2678	2308	3182	2834	3709	3331	4301	110
	40	2016	2804	2565	3478	3104	4078	3662	4728	4292	5472	130
	45	2552	3507	3169	4237	3797	4929	4463	5699	5223	6587	149
	50	3065	4164	3763	4945	4456	5725	5226	6607	6108	7632	165
	55	3547	4770	4302	5600	5075	6462	5942	7450	6940	8602	180
	60	3998	5325	4805	6202	5653	7141	6612	8228	7718	9498	194
	65	4413	[illegible]	5273	6754	6191	7766	7233	8944	8444	10325	206
40	40	1715	2393	2187	2939	2622	3442	3092	3989	3623	4615	110
	45	2207	3029	2747	3646	3263	4238	3839	4899	4492	5662	128
	50	2663	3645	3269	4318	3892	4996	4563	5766	5333	6659	144
	55	3143	4223	3806	4949	4487	5709	5253	6582	6134	7599	159
	60	3575	4760	4293	5537	5049	6374	5905	7344	6893	8478	173
	65	3981	5257	4752	6082	5578	6992	6518	8053	7606	9295	186
	70	4361	5715	5182	6585	6074	7565	7094	8712	8275	10057	197
45	45	1910	2617	2367	3138	2812	3643	3303	4210	3863	4866	110
	50	2355	3191	2875	3770	3399	4360	3984	5031	4656	5810	126
	55	2796	3739	3367	4374	3967	5043	4643	5814	5422	6713	141
	60	3199	4255	3833	4943	4510	5629	5273	6554	6155	7567	155
	65	3592	4739	4353	5476	[illegible]	[illegible]	5372	7251	6852	8370	167
	70	3962	5188	4704	5975	5513	6603	6478	7903	7510	9123	179
	75	4311	5607	5102	6440	5973	7392	6972	8512	8132	9827	189
50	50	2065	2794	2514	3292	2969	3804	3479	4389	4065	5069	110
	55	2471	3310	2978	3865	3507	4455	4105	5135	4793	5930	124
	60	2864	3803	3428	4412	4028	5077	4710	5850	5497	6754	138
	65	3241	4270	3890	4931	4528	5668	5290	6528	6172	7536	151
	70	3600	4709	4271	5420	5004	6225	5943	7168	6616	8276	162
	75	3941	5121	4661	5879	5456	6743	6369	7771	7428	8972	173
	80	4265	5507	5031	6310	5885	7241	6867	8338	8008	9628	183
55	55	2191	2931	2635	3415	3101	3935	3628	4536	4236	5237	110
	60	2563	3400	3064	3938	3598	4531	4206	5220	4909	6027	123
	65	2924	3848	3479	4439	4079	5102	4766	5877	5560	6785	136
	70	3272	4274	3877	4916	4542	5646	5303	6502	6186	7507	147
	75	3604	4677	4259	5357	4984	6161	5818	7095	6785	8192	158
	80	3921	5057	4623	5794	5406	6648	6308	7656	7356	8840	168
60	60	2295	3039	2738	3515	3214	4043	3757	4658	4384	5378	110
	65	2639	3468	3135	3997	3675	4593	4293	5290	5008	6108	122
	70	2973	3879	3520	4459	4122	5120	4813	5897	5614	6809	134
	75	3295	4272	3892	4900	4553	5624	5314	6477	6197	7479	144
	80	3604	4645	4248	5319	4967	6104	5795	7029	6757	8117	155
65	65	2382	3125	2826	3598	3312	4134	3868	4762	4512	5498	110
	70	2702	3521	3196	4044	3742	4643	4368	5348	5095	6175	121
	75	3013	3901	3556	4472	4160	5134	4854	5913	5661	6828	132
	80	3314	4265	3903	4883	4563	5603	5324	6453	6207	7453	142
70	70	2456	3195	2902	3667	3397	4211	3965	4850	4624	5601	110
	75	2756	3562	3249	4082	3800	4686	4434	5397	5171	6233	120
	80	3047	3916	3586	4482	4192	5144	4890	5925	5702	6842	130
75	75	2520	3253	2969	3726	3471	4277	4051	4926	4723	5689	110
	80	2801	3596	3295	4114	3851	4722	4493	5439	5238	6282	120
80	80	2576	3301	3028	3776	3538	4334	4127	4992	4812	5767	110

TABLE 25.--CURRENT AND PROJECTED MERCHANTABLE CUBIC FOOT VOLUME(V41,V40) AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX 50		60		70		80		90		PROJECTED BASAL AREA
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
120 SQ. FT. INITIAL BASAL AREA												
20	20	463	685	919	1331	1334	1894	1715	2392	2100	2886	120
	25	1107	1610	1821	2583	2405	3332	2954	4018	3532	4734	155
	30	1887	2705	2763	3844	3475	4719	4178	5570	4943	6497	183
	35	2683	3792	3653	4999	4474	5975	5319	6976	6258	8097	207
	40	3433	4787	4463	6020	5381	7096	6357	8225	7455	9522	227
	45	4113	5666	5189	6913	6196	8061	7290	9325	8534	10780	243
	50	4721	6432	5938	7601	6926	8917	8129	10333	9503	11832	257
25	25	866	1260	1417	2017	1868	2588	2293	3117	2740	3672	120
	30	1540	2208	2242	3119	2815	3822	3393	4508	4001	5256	148
	35	2253	3103	3053	4176	3735	4985	4438	5518	5220	6751	173
	40	2943	4102	3813	5141	4593	6045	5424	7015	6361	8120	193
	45	3584	4934	4511	6005	5392	6998	6331	8095	7410	9358	211
	50	4168	5675	5145	6774	6101	7851	7158	9063	8369	10469	227
	55	4697	6331	5720	7458	6754	8612	7911	9931	9242	11466	240
30	30	1260	1806	1821	2532	2282	3096	2739	3648	3238	4252	120
	35	1894	2675	2553	3490	3118	4159	3703	4851	4354	5629	144
	40	2525	3517	3259	4390	3921	5158	4629	5983	5427	6925	165
	45	3124	4298	3922	5217	4675	6076	5498	7027	6435	8122	183
	50	3681	5008	4535	5967	5374	6912	6305	7979	7370	9216	200
	55	4193	5647	5099	6644	6018	7670	7049	8844	8233	10211	214
	60	4662	6221	5516	7255	6610	8357	7733	9629	9027	11115	227
35	35	1594	2250	2136	2917	2604	3470	3090	4046	3633	4693	120
	40	2168	3017	2766	3750	3343	4400	3950	5103	4631	5906	141
	45	2725	3745	3410	4532	4062	5275	4775	6093	5588	7049	159
	50	3252	4420	3997	5255	4735	6085	5553	7024	6491	8113	176
	55	3744	5038	4545	5919	5363	6831	6280	7876	7335	9093	191
	60	4200	5600	5054	6525	5946	7514	6956	8658	8120	9995	204
	65	4621	6111	5525	7078	6488	8140	7583	9375	8848	10821	216
40	40	1663	2590	2392	3203	2859	3754	3372	4352	3951	5036	120
	45	2378	3265	2995	3938	3529	4579	4147	5294	4853	6118	138
	50	2874	3902	3524	4629	4171	5357	4891	6183	5716	7141	155
	55	3344	4495	4052	5272	4779	6083	5595	7013	6535	8097	170
	60	3785	5042	4548	5868	5350	6756	6257	7784	7304	8966	183
	65	4197	5544	5012	6417	5884	7378	6877	8498	8024	9810	196
	70	4580	6006	5445	6923	6383	7953	7455	9158	8697	10571	207
45	45	2076	2847	2579	3421	3055	3975	3602	4594	4214	5310	120
	50	2540	3445	3107	4077	3675	4716	4308	5442	5035	6286	136
	55	2987	4010	3613	4697	4259	5417	4985	6245	5822	7210	151
	60	3411	4539	4093	5277	4813	6074	5629	6998	6570	8079	165
	65	3811	5030	4547	5817	5337	6600	6236	7703	7277	8892	177
	70	4187	5486	4974	6320	5829	7259	6808	8359	7942	9650	189
	75	4539	5907	5374	6766	6282	7791	7346	8970	8567	10356	200
50	50	2245	3042	2739	3591	3238	4151	3795	4790	4434	5532	120
	55	2668	3579	3221	4183	3795	4823	4442	5560	5187	6420	135
	60	3074	4067	3694	4745	4330	5461	5063	6292	5910	7264	148
	65	3461	4564	4125	5273	4810	6092	5656	6982	6599	8060	161
	70	3828	5010	4543	5769	5324	6626	6218	7630	7253	8809	173
	75	4174	5427	4939	6232	5781	7154	6749	8239	7871	9511	183
	80	4501	5815	5312	6665	6213	7648	7251	8907	8455	10168	193
55	55	2384	3193	2873	3726	3382	4295	3958	4950	4621	5716	120
	60	2771	3679	3316	4267	3896	4909	4555	5656	5316	6530	133
	65	3144	4141	3743	4780	4390	5494	5129	6328	5984	7306	146
	70	3500	4576	4151	5265	4862	6048	5678	6964	6623	8040	158
	75	3838	4986	4539	5723	5312	6569	6201	7565	7231	8734	168
	80	4160	5370	4907	6153	5739	7051	6697	8131	7809	9388	179
60	60	2498	3312	2985	3836	3505	4413	4097	5084	4782	5870	120
	65	2856	3756	3396	4333	3932	4979	4652	5735	5427	6622	132
	70	3200	4179	3792	4806	4441	5519	5185	6356	6048	7339	144
	75	3530	4580	4171	5255	4881	6032	5697	6947	6644	8021	155
	80	3845	4959	4533	5680	5301	6518	6186	7506	7213	8667	165
65	65	2594	3408	3081	3927	3612	4512	4219	5198	4921	6001	120
	70	2926	3817	3464	4386	4056	5037	4736	5801	5523	6698	13.
	75	3246	4207	3833	4825	4485	5539	5234	6379	6104	7365	142
	80	3554	4579	4168	5243	4896	6017	5713	6929	6662	8002	152
70	70	2676	3485	3165	4003	3705	4597	4325	5294	5044	6113	120
	75	2986	3865	3523	4430	4121	5085	4809	5857	5608	6763	131
	80	3285	4228	3869	4840	4523	5554	5277	6397	6153	7387	141
75	75	2746	3550	3238	4067	3786	4669	4419	5378	5152	6210	120
	80	3037	3903	3574	4467	4178	5126	4874	5905	5683	6819	130
80	80	2807	3603	3302	4123	3859	4731	4502	5450	5249	6295	120

TABLE 26.--CURRENT AND PROJECTED MERCHANTABLE CUBIC FOOT VOLUME(V41,V40) AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX 50		60		70		80		90		PROJECTED BASAL AREA
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
130 SQ. FT. INITIAL BASAL AREA												
20	20	503	743	996	1443	1446	2052	1859	2592	2275	3127	130
	25	1178	1714	1940	2752	2563	3552	3149	4283	3765	5047	165
	30	1937	2848	2912	4052	3664	4977	4407	5875	5214	6853	193
	35	2805	3964	3922	5231	4692	6254	5568	7303	6551	8476	217
	40	3569	4978	4643	6265	5600	7375	6616	8561	7759	9911	236
	45	4258	5837	5376	7162	6420	8353	7554	9664	8843	11171	252
	50	4872	6538	6027	7941	7151	9207	8392	10631	9812	12279	266
25	25	935	1351	1533	2175	2022	2802	2483	3376	2968	3977	130
	30	1642	2353	2394	3331	3008	4084	3615	4818	4276	5619	159
	35	2380	3363	3230	4419	3953	5277	4699	6160	5527	7149	183
	40	3029	4306	4007	5403	4828	6355	5702	7375	6687	8538	203
	45	3742	5154	4714	6277	5626	7317	6618	8464	7747	9784	221
	50	4335	5903	5354	7050	6349	8172	7450	9434	8710	10897	236
	55	4908	6562	5931	7734	7004	8932	8204	10300	9584	11892	249
30	30	1399	1948	1970	2739	2470	3352	2966	3951	3507	4607	130
	35	2022	2856	2731	3735	3338	4453	3965	5196	4663	6029	154
	40	2675	3727	3458	4660	4153	5476	4914	6354	5762	7354	175
	45	3290	4528	4134	5501	4931	6409	5799	7412	6787	8568	193
	50	3858	5250	4756	6260	5638	7253	6614	8372	7733	9670	209
	55	4377	5895	5325	6940	6286	8013	7363	9240	8600	10668	223
	60	4849	6473	5844	7552	6879	8699	8048	10023	9396	11571	236
35	35	1720	2428	2311	3157	2819	3758	3346	4383	3935	5084	130
	40	2318	3228	2985	4020	3530	4719	4235	5474	4936	6335	151
	45	2894	3979	3626	4822	4322	5614	5081	6491	5946	7503	169
	50	3434	4670	4226	5558	5006	6437	5872	7429	6865	8581	186
	55	3936	5296	4791	6228	5642	7189	6608	8288	7718	9570	201
	60	4398	5935	5294	6837	6230	7874	7288	9073	8508	10474	214
	65	4832	6379	5767	7391	6773	8439	7916	9769	9239	11300	225
40	40	2010	2797	2578	3468	3095	4067	3551	4715	4280	5457	130
	45	2546	3498	3181	4227	3786	4917	4452	5685	5210	6571	148
	50	3058	4155	3755	4934	4446	5712	5214	6593	6094	7615	165
	55	3540	4760	4293	5598	5064	6449	5930	7435	6926	8584	180
	60	3988	5315	4796	6190	5642	7128	6600	8212	7704	9481	193
	65	4405	5923	5264	6742	6180	7752	7223	8929	8429	10307	206
	70	4792	6296	5693	7243	6581	8327	7804	9569	9104	11068	217
45	45	2241	3076	2791	3705	3320	4307	3901	4978	4565	5754	130
	50	2724	3697	3336	4381	3948	5069	4629	5850	5410	6757	146
	55	3184	4278	3855	5015	4546	5795	5322	6669	6215	7700	161
	60	3618	4817	4345	5604	5110	6452	5976	7433	6976	8581	175
	65	4025	5315	4805	6150	5640	7071	6591	8144	7691	9401	188
	70	4405	5774	5235	6655	6137	7644	7168	8803	8361	10162	199
	75	4760	6137	5638	7122	6601	8176	7707	9414	8989	10867	209
50	50	2427	3290	2965	3890	3506	4498	4110	5190	4803	5995	130
	55	2864	3845	3462	4493	4080	5189	4776	5982	5578	6907	145
	60	3282	4365	3937	5073	4628	5939	5412	6728	6317	7767	159
	65	3677	4852	4326	5609	5147	6493	6014	7427	7018	8574	171
	70	4050	5304	4810	6110	5637	7018	6583	8031	7679	9329	183
	75	4400	5724	5208	6575	6098	7548	7119	8692	8302	10034	193
	80	4720	6114	5563	7009	6531	8043	7623	9261	8888	10692	203
55	55	2577	3455	3110	4037	3663	4654	4287	5365	5006	6195	130
	60	2978	3957	3567	4592	4192	5285	4901	6089	5720	7030	144
	65	3360	4429	4004	5118	4697	5881	5488	6774	6403	7820	156
	70	3724	4872	4419	5609	5177	6442	6046	7419	7053	8565	168
	75	4068	5297	4812	6071	5633	6969	6575	8025	7668	9265	179
	80	4393	5674	5194	6503	6063	7462	7076	8593	8251	9921	189
60	60	2702	3586	3232	4157	3796	4783	4438	5510	5180	6362	130
	65	3071	4043	3655	4667	4295	5363	5008	6177	5843	7132	142
	70	3424	4476	4060	5149	4756	5914	5553	6810	6478	7863	154
	75	3761	4883	4446	5605	5203	6434	6073	7409	7083	8554	165
	80	4030	5266	4813	6034	5628	6924	6568	7973	7659	9206	175
65	65	2806	3690	3336	4256	3912	4891	4570	5633	5331	6504	130
	70	3148	4111	3730	4727	4368	5428	5101	6252	5949	7218	142
	75	3477	4510	4107	5174	4806	5939	5610	6840	6542	7897	152
	80	3790	4887	4468	5598	5225	6424	6097	7398	7109	8542	163
70	70	2895	3776	3427	4339	4013	4983	4685	5738	5464	6626	130
	75	3214	4165	3795	4777	4440	5483	5182	6314	6043	7291	141
	80	3521	4535	4148	5193	4850	5960	5660	6864	6599	7926	151
75	75	2972	3846	3506	4409	4101	5061	4786	5829	5581	6731	130
	80	3271	4209	3852	4818	4503	5529	5254	6368	6125	7354	140
80	80	3038	3905	3576	4469	4180	5129	4877	5908	5686	6823	130

TABLE 27.--CURRENT AND PROJECTED MERCHANTABLE CUBIC FOOT VOLUME(V41,V40) AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

140 SQ. FT. INITIAL BASAL AREA

INITIAL AGE	FINAL AGE	SITE INDEX 50 I.B.	50 O.B.	60 I.B.	60 O.B.	70 I.B.	70 O.B.	80 I.B.	80 O.B.	90 I.B.	90 O.B.	PROJECTED BASAL AREA
YEARS												SQ. FT.
20	20	542	802	1074	1555	1557	2211	2002	2792	2451	3368	140
	25	1248	1815	2057	2918	2719	3767	3341	4544	3995	5355	175
	30	2084	2987	3057	4255	3849	5228	4629	6172	5477	7200	203
	35	2922	4130	3985	5455	4834	6524	5808	7619	6834	8843	226
	40	3700	5161	4817	6500	5811	7653	6665	8884	8052	10285	245
	45	4398	6060	5555	7401	6634	8633	7806	9988	9139	11546	261
	50	5016	6835	6207	8173	7365	9485	8644	10951	10107	12650	274
25	25	1004	1462	1650	2340	2177	3016	2673	3635	3196	4283	140
	30	1742	2497	2544	3540	3193	4343	3845	5124	4548	5976	169
	35	2505	3539	3404	4657	4167	5563	4953	6495	5827	7537	193
	40	3231	4504	4195	5657	5055	6656	5971	7725	7003	8943	213
	45	3896	5365	4911	6540	5832	7624	6836	8220	8072	10196	230
	50	4495	6122	5554	7316	6580	8481	7731	9791	9039	11309	245
	55	5032	6785	6133	7993	7243	9239	8485	10653	9912	12300	258
30	30	1458	2090	2118	2947	2658	3608	3194	4255	3776	4961	140
	35	2149	3035	2908	3977	3505	4744	4224	5536	4938	6424	164
	40	2822	3933	3653	4924	4399	5789	5195	6717	6091	7775	185
	45	3452	4752	4342	5779	5179	6734	6092	7788	7130	9003	203
	50	4029	5485	4971	6544	5893	7583	6915	8754	8084	10111	219
	55	4554	6136	5543	7227	6545	8345	7666	9622	8955	11109	233
	60	5029	6715	6064	7837	7138	9028	8351	10403	9750	12009	245
35	35	1845	2605	2465	3395	3034	4046	3603	4720	4236	5476	140
	40	2467	3436	3182	4287	3829	5033	4519	5841	5203	6760	161
	45	3060	4209	3939	5107	4577	5947	5362	6877	6199	7950	179
	50	3613	4914	4449	5853	5272	6780	6195	7826	7230	9040	196
	55	4122	5550	5011	6529	5914	7537	6926	8600	8090	10033	210
	60	4589	6122	5527	7140	6505	8223	7609	9475	8883	10938	223
	65	5016	6637	6001	7692	7049	8847	8238	10189	9614	11761	235
40	40	2158	3003	2773	3732	3332	4379	3931	5078	4608	5877	140
	45	2713	3730	3395	4513	4045	5252	4755	6073	5564	7019	159
	50	3240	4403	3992	5235	4716	6052	5532	6905	6466	8081	175
	55	3731	5020	4529	5898	5344	6807	6258	7848	7309	9051	190
	60	4187	5592	5038	6504	5927	7490	6933	8630	8094	9962	203
	65	4608	6093	5508	7057	6468	8115	7560	9347	8822	10789	215
	70	4997	6557	5944	7563	6970	8688	8141	10004	9497	11548	226
45	45	2407	3306	3003	3908	3574	4638	4201	5362	4915	6197	140
	50	2906	3946	3604	4633	4219	5420	4948	6255	5783	7224	157
	55	3378	4541	4095	5323	4829	6147	5654	7037	6604	8183	172
	60	3821	5090	4592	5925	5401	6822	6317	7850	7374	9073	185
	65	4233	5594	5057	6474	5936	7444	6938	8574	8096	9697	197
	70	4617	6055	5490	6961	6435	8019	7517	9234	8769	10659	209
	75	4975	6479	5833	7447	6901	8549	8057	9843	9397	11363	219
50	50	2607	3537	3191	4188	3775	4845	4426	5591	5172	6458	140
	55	3059	4109	3702	4313	4304	5502	5109	6400	5966	7390	155
	60	3487	4641	4186	5397	4892	6213	5736	7153	6719	8264	169
	65	3890	5135	4642	5940	5448	6929	6367	7865	7429	9079	181
	70	4267	5592	5070	6443	5943	7401	6941	8523	8096	9838	193
	75	4621	6014	5471	6910	6406	7932	7479	9134	8723	10544	203
	80	4951	6404	5847	7343	6841	8426	7984	9702	9310	11201	213
55	55	2770	3717	3347	4348	3944	5014	4616	5779	5390	6673	140
	60	3183	4232	3816	4916	4485	5658	5245	6519	6122	7526	154
	65	3574	4714	4261	5449	5000	6264	5843	7214	6817	8328	166
	70	3944	5164	4682	5947	5487	6831	6408	7835	7475	9081	178
	75	4292	5582	5080	6412	5947	7360	6942	8475	8096	9784	189
	80	4620	5971	5454	6845	6330	7855	7445	9044	8682	10442	199
60	60	2905	3769	3479	4478	4038	5153	4779	5937	5578	6854	140
	65	3284	4328	3912	4933	4599	5745	5362	6617	6256	7639	153
	70	3645	4769	4325	5489	5067	6304	5917	7259	6902	8381	164
	75	3987	5181	4716	5949	5520	6823	6444	7864	7515	9079	175
	80	4311	5568	5087	6381	5950	7322	6943	8431	8096	9735	185
65	65	3018	3923	3591	4585	4212	5269	4921	6069	5741	7007	140
	70	3369	4403	3994	5065	4679	5818	5464	6700	6373	7735	152
	75	3704	4809	4379	5520	5125	6336	5982	7296	6976	8424	162
	80	4023	5191	4745	5986	5549	6825	6475	7859	7550	9075	173
70	70	3114	4056	3689	4675	4321	5369	5045	6183	5884	7138	140
	75	3441	4464	4065	5121	4757	5978	5553	6769	6475	7816	151
	80	3754	4840	4425	5544	5175	6362	6038	7326	7041	8460	161
75	75	3197	4143	3775	4751	4416	5453	5154	6280	6011	7252	140
	80	3503	4513	4128	5167	4826	5930	5631	6829	6566	7886	150
80	80	3263	4207	3850	4816	4501	5527	5252	6365	6123	7351	140

TABLE 28.--CURRENT AND PROJECTED MERCHANTABLE CUBIC FOOT VOLUME(V41,V40) AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX 50		60		70		80		90		PROJECTED BASAL AREA
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
150 SQ. FT. INITIAL BASAL AREA												
20	20	582	860	1151	1667	1669	2369	2145	2992	2626	3609	150
	25	1317	1915	2173	3082	2872	3960	3530	4801	4221	5658	185
	30	2178	3122	3199	4453	4029	5473	4846	6462	5735	7538	213
	35	3035	4291	4144	5673	5079	6785	6041	7925	7108	9199	235
	40	3826	5337	4985	6726	6014	7921	7105	9196	8334	10647	253
	45	4531	6245	5726	7931	6840	8902	8049	10299	9423	11906	269
	50	5153	7024	6379	8408	7571	9750	8885	11258	10390	13004	281
25	25	1074	1562	1766	2505	2331	3230	2864	3894	3424	4589	150
	30	1841	2638	2693	3747	3386	4599	4071	5427	4816	6330	179
	35	2626	3711	3573	4890	4376	5843	5202	6823	6121	7916	202
	40	3368	4697	4378	5905	5278	6949	6234	8066	7311	9337	222
	45	4044	5571	5101	6794	6090	7922	7165	9165	8387	10595	239
	50	4650	6334	5748	7572	6819	8779	8002	10135	9356	11707	253
	55	5190	6998	6327	8234	7473	9534	8735	10993	10227	12693	266
30	30	1557	2232	2267	3154	2847	3604	3421	4558	4046	5315	150
	35	2274	3212	3082	4216	3770	5032	4480	5874	5270	6816	174
	40	2967	4135	3845	5184	4632	6096	5470	7074	6414	8189	195
	45	3610	4970	4544	6050	5422	7051	6378	8155	7466	9427	213
	50	4196	5713	5179	6820	6142	7904	7206	9124	8425	10539	228
	55	4725	6369	5754	7504	6755	8665	7960	9992	9298	11536	242
	60	5203	6940	6276	8113	7389	9346	8644	10769	10092	12431	253
35	35	1970	2783	2659	3536	3249	4334	3859	5057	4538	5867	150
	40	2614	3642	3378	4551	4065	5348	4799	6204	5627	7181	171
	45	3223	4435	4049	5387	4823	6275	5578	7257	6645	8389	189
	50	3787	5153	4667	6142	5532	7116	6490	8214	7587	9488	205
	55	4303	5796	5234	6822	6179	7876	7237	9081	8453	10485	220
	60	4774	6372	5753	7433	6771	8502	7922	9865	9248	11388	232
	65	5203	6897	6227	7984	7314	9182	8550	10576	9977	12207	243
40	40	2305	3209	2968	3926	3559	4691	4211	5441	4937	6298	150
	45	2879	3959	3603	4797	4273	5560	5055	6458	5915	7464	169
	50	3419	4648	4206	5532	4983	6405	5845	7394	6832	8541	185
	55	3919	5275	4761	6201	5619	7158	6579	8253	7685	9529	200
	60	4391	5843	5274	6810	6236	7843	7259	9037	8475	10433	213
	65	4805	6356	5746	7334	6748	8469	7888	9754	9204	11259	225
	70	5190	6820	6182	7868	7248	9039	8468	10408	9879	12014	235
45	45	2573	3535	3215	4272	3828	4970	4500	5746	5266	6641	150
	50	3087	4194	3791	4932	4483	5767	5264	6656	6153	7688	167
	55	3570	4802	4331	5637	5102	6505	5993	7500	6997	8660	182
	60	4020	5358	4834	6240	5687	7165	6652	8279	7765	9557	195
	65	4438	5866	5303	6792	6226	7810	7277	8935	8491	10383	207
	70	4824	6329	5739	7299	6727	8384	7858	9654	9166	11144	218
	75	5183	6752	6141	7763	7192	8912	8397	10261	9794	11845	228
50	50	2788	3784	3416	4497	4043	5192	4741	5992	5541	6921	150
	55	3252	4371	3940	5125	4645	5912	5439	6816	6352	7870	165
	60	3689	4913	4432	5717	5213	6602	6096	7583	7116	8755	179
	65	4098	5413	4894	6264	5745	7202	6713	8295	7834	9576	191
	70	4480	5874	5325	6770	6242	7777	7291	8955	8505	10337	202
	75	4836	6297	5728	7237	6707	8308	7831	9565	9133	11043	213
	80	5168	6685	6104	7668	7142	8799	8335	10131	9720	11695	222
55	55	2963	3978	3584	4659	4224	5373	4945	6194	5775	7152	150
	60	3386	4506	4063	5238	4777	6029	5587	6946	6521	8019	164
	65	3785	4993	4516	5777	5300	6642	6194	7650	7227	8831	176
	70	4161	5451	4942	6279	5792	7213	6765	8306	7892	9588	188
	75	4513	5872	5342	6746	6255	7744	7302	8917	8515	10294	198
	80	4843	6262	5718	7179	6690	8238	7807	9486	9103	10952	208
60	60	3109	4132	3725	4798	4379	5523	5120	6363	5976	7346	150
	65	3496	4611	4163	5318	4890	6125	5714	7054	6667	8144	163
	70	3864	5053	4587	5824	5375	6690	6277	7704	7322	8894	174
	75	4211	5475	4983	6289	5833	7219	6810	8312	7942	9596	185
	80	4539	5864	5355	6721	6255	7713	7312	8691	8526	10254	195
65	65	3230	4255	3846	4914	4512	5648	5272	6505	6151	7510	150
	70	3589	4694	4257	5402	4980	6205	5925	7145	6794	8249	162
	75	3930	5106	4647	5862	5440	6729	6350	7748	7406	8946	173
	80	4253	5491	5017	6293	5869	7221	6848	8315	7985	9601	183
70	70	3333	4356	3951	5011	4628	5754	5405	6627	6304	7651	150
	75	3667	4761	4335	5464	5073	6272	5922	7222	6906	8339	161
	80	3985	5142	4700	5891	5496	6760	6414	7785	7479	8989	171
75	75	3423	4439	4043	5093	4731	5846	5522	6732	6440	7773	150
	80	3735	4815	4403	5515	5148	6329	6007	7288	7004	8416	160
80	80	3500	4508	4124	5163	4822	5925	5626	6823	6560	7879	150

Current and Projected Merchantable Cubic Foot Volume (V10I, V10O) and Total Basal Area Per Acre

TABLE 29.--CURRENT AND PROJECTED MERCHANTABLE CUBIC FOOT VOLUME(V101,V100) AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX 50		60		70		80		90		PROJECTED BASAL AREA
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
						20 SQ. FT. INITIAL BASAL AREA						
20	20	0	0	1	1	4	6	16	21	43	59	20
	25	1	1	6	8	30	40	94	126	215	289	37
	30	3	4	27	36	112	148	300	396	594	780	56
	35	12	16	81	105	287	374	667	866	1169	1510	74
	40	33	42	167	242	577	743	1181	1514	1882	2398	93
	45	74	96	365	468	980	1252	1801	2286	2672	3365	110
	50	146	189	624	796	1479	1875	2484	3125	3492	4356	126
25	25	0	1	4	6	21	29	65	87	143	191	20
	30	3	4	23	31	93	123	235	310	437	574	33
	35	12	16	78	103	260	341	557	726	907	1171	48
	40	36	47	195	254	546	709	1015	1306	1501	1913	63
	45	87	113	393	509	943	1212	1565	1992	2167	2730	78
	50	177	231	680	877	1421	1812	2165	2730	2865	3575	93
	55	321	417	1048	1343	1947	2464	2784	3481	3570	4418	106
30	30	2	3	18	23	68	89	164	216	292	383	20
	35	11	14	66	85	206	270	416	541	645	830	31
	40	34	45	175	228	454	539	787	1010	1110	1410	43
	45	88	115	367	476	801	1030	1240	1576	1648	2071	56
	50	186	244	644	833	1218	1554	1742	2194	2227	2774	68
	55	344	449	994	1278	1675	2120	2267	2832	2826	3492	81
	60	568	740	1392	1780	2148	2701	2799	3471	3430	4209	93
35	35	9	11	50	65	151	197	293	378	440	563	20
	40	30	39	143	186	350	452	578	738	792	1002	29
	45	80	105	312	404	635	814	939	1188	1217	1523	40
	50	177	231	559	722	992	1249	1349	1693	1690	2097	50
	55	334	436	868	1115	1366	1725	1788	2227	2193	2702	61
	60	554	723	1218	1555	1769	2219	2243	2774	2712	3320	72
	65	831	1081	1588	2016	2179	2716	2703	3323	3238	3941	82
40	40	24	31	110	142	258	330	413	523	555	697	20
	45	69	89	250	322	484	615	694	872	885	1102	28
	50	156	203	459	589	765	968	1024	1278	1266	1565	37
	55	301	392	722	923	1083	1361	1387	1721	1684	2068	46
	60	505	657	1020	1298	1423	1778	1773	2185	2127	2595	56
	65	759	984	1337	1693	1775	2205	2171	2661	2584	3137	65
	70	1044	1351	1662	2092	2131	2634	2575	3140	3049	3683	74
45	45	55	70	193	246	360	453	506	630	639	789	20
	50	131	169	364	463	584	733	769	953	943	1158	27
	55	259	335	582	739	845	1055	1067	1316	1287	1572	35
	60	439	569	832	1053	1129	1403	1391	1707	1660	2018	43
	65	663	855	1102	1388	1430	1768	1733	2116	2055	2486	51
	70	914	1176	1392	1732	1740	2142	2087	2537	2463	2967	60
	75	1180	1513	1666	2078	2055	2519	2447	2962	2880	3455	68
50	50	106	134	282	354	441	547	573	704	700	852	20
	55	215	275	460	578	652	808	816	999	980	1190	26
	60	370	474	669	838	899	1098	1087	1326	1293	1564	33
	65	563	721	895	1121	1144	1408	1379	1676	1630	1965	41
	70	780	937	1136	1416	1413	1731	1686	2042	1986	2385	48
	75	1010	1288	1384	1718	1690	2053	2005	2419	2355	2817	56
	80	1246	1583	1635	2022	1973	2399	2330	2801	2732	3257	63
55	55	174	218	359	445	501	613	622	755	745	898	20
	60	305	386	531	659	697	853	847	1026	1005	1208	26
	65	468	594	722	896	913	1115	1095	1323	1292	1549	32
	70	654	830	928	1148	1144	1393	1360	1640	1600	1913	39
	75	853	1080	1143	1411	1386	1684	1640	1971	1924	2294	45
	80	1059	1336	1364	1679	1637	1983	1929	2312	2260	2687	52
60	60	247	307	419	513	544	659	659	791	781	931	20
	65	384	481	579	711	726	879	868	1042	1023	1219	25
	70	543	681	754	926	924	1118	1096	1314	1288	1532	31
	75	714	895	941	1153	1135	1371	1340	1603	1571	1866	37
	80	893	1118	1135	1389	1357	1636	1596	1905	1869	2214	43
65	65	312	385	462	561	576	691	687	818	809	958	20
	70	446	553	611	743	745	894	883	1051	1036	1226	25
	75	593	736	772	939	929	1114	1095	1302	1282	1515	30
	80	749	929	943	1145	1123	1347	1320	1568	1545	1823	36
70	70	365	445	494	593	601	714	710	839	833	979	20
	75	491	601	633	762	759	903	894	1056	1046	1230	25
	80	625	768	782	942	930	1107	1092	1290	1276	1499	29
75	75	404	488	518	616	620	731	729	855	854	996	20
	80	521	632	648	773	769	909	902	1059	1055	1232	24
80	80	433	518	536	633	636	745	745	869	871	1011	20

TABLE 30.--CURRENT AND PROJECTED MERCHANTABLE CUBIC FOOT VOLUME(V101,V100) AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX 50		60		70		80		90		PROJECTED BASAL AREA
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
30 SQ. FT. INITIAL BASAL AREA												
20	20	0	0	1	1	5	7	20	28	56	76	30
	25	1	1	7	9	33	44	106	142	250	334	51
	30	3	4	27	35	114	149	316	414	652	853	73
	35	11	14	75	98	278	359	679	877	1253	1614	94
	40	29	37	169	217	546	699	1188	1517	2002	2543	113
	45	63	81	323	411	923	1172	1814	2293	2838	3565	131
	50	122	156	549	695	1402	1766	2519	3156	3714	4622	148
25	25	1	1	6	7	27	36	84	113	190	255	30
	30	3	4	26	35	107	141	281	371	544	714	47
	35	12	16	82	107	283	370	639	831	1088	1406	64
	40	34	45	194	252	577	747	1140	1465	1766	2251	81
	45	80	103	382	492	986	1263	1743	2216	2516	3171	98
	50	159	206	655	840	1485	1888	2402	3026	3296	4113	113
	55	285	367	1012	1291	2044	2580	3084	3853	4076	5045	128
30	30	3	4	22	29	88	116	220	290	404	531	30
	35	12	16	76	100	250	328	528	688	849	1097	44
	40	36	47	192	251	530	688	969	1247	1417	1805	58
	45	88	115	391	508	919	1182	1500	1909	2055	2589	73
	50	181	236	679	876	1386	1769	2080	2622	2728	3404	87
	55	329	428	1046	1342	1899	2405	2679	3350	3411	4221	100
	60	541	702	1471	1878	2431	3057	3279	4070	4088	5022	113
35	35	11	14	64	84	202	264	406	527	628	808	30
	40	34	45	173	225	446	579	770	989	1084	1377	42
	45	87	114	363	472	789	1015	1217	1546	1613	2027	54
	50	186	243	639	827	1201	1532	1711	2155	2184	2719	67
	55	344	450	986	1268	1652	2091	2230	2785	2775	3429	79
	60	569	741	1381	1766	2120	2655	2756	3417	3373	4138	91
	65	855	1112	1801	2290	2590	3235	3279	4039	3957	4837	102
40	40	30	39	145	188	356	459	589	753	809	1023	30
	45	81	105	315	409	644	826	955	1209	1239	1552	40
	50	178	232	565	729	995	1267	1370	1720	1718	2133	51
	55	335	439	877	1126	1384	1748	1814	2260	2226	2744	62
	60	556	726	1229	1570	1791	2247	2273	2812	2751	3368	73
	65	834	1085	1602	2035	2204	2748	2737	3365	3281	3993	83
	70	1154	1496	1981	2502	2616	3243	3199	3911	3810	4612	94
45	45	71	92	262	338	510	651	736	927	942	1173	30
	50	161	209	478	615	804	1018	1080	1350	1339	1656	39
	55	309	402	750	960	1134	1427	1458	1809	1772	2177	49
	60	516	672	1059	1347	1485	1857	1855	2289	2229	2722	58
	65	774	1006	1385	1754	1849	2297	2265	2778	2699	3278	68
	70	1067	1381	1719	2165	2214	2737	2679	3269	3176	3837	78
	75	1379	1777	2053	2573	2579	3173	3093	3756	3652	4393	87
50	50	139	180	393	502	639	804	844	1049	1038	1277	30
	55	273	354	625	796	917	1147	1162	1436	1404	1719	38
	60	462	599	891	1129	1218	1517	1505	1850	1799	2190	47
	65	695	899	1175	1483	1535	1901	1865	2280	2214	2681	55
	70	957	1235	1469	1844	1959	2292	2234	2719	2640	3183	64
	75	1235	1586	1766	2206	2187	2684	2609	3161	3073	3689	73
	80	1518	1941	2061	2563	2316	3073	2985	3601	3507	4194	81
55	55	235	302	513	648	735	913	923	1134	1110	1352	30
	60	402	517	740	932	992	1229	1217	1489	1449	1757	37
	65	608	782	986	1237	1267	1563	1531	1865	1812	2188	45
	70	840	1078	1244	1554	1554	1909	1659	2255	2191	2635	53
	75	1086	1389	1507	1875	1848	2261	2196	2654	2582	3093	61
	80	1338	1703	1773	2197	2146	2615	2538	3056	2978	3554	69
60	60	342	437	608	760	805	990	981	1194	1166	1407	30
	65	523	667	821	1023	1043	1279	1254	1521	1481	1782	37
	70	727	926	1046	1300	1295	1584	1544	1866	1817	2178	44
	75	944	1200	1280	1585	1558	1898	1846	2224	2167	2589	51
	80	1167	1478	1518	1874	1827	2219	2156	2589	2527	3009	58
65	65	444	561	690	841	856	1043	1026	1238	1210	1449	30
	70	622	786	876	1082	1078	1311	1281	1542	1506	1798	36
	75	812	1026	1083	1334	1311	1591	1550	1961	1818	2166	43
	80	1010	1272	1296	1593	1554	1880	1830	2191	2143	2545	49
70	70	528	661	732	896	895	1082	1062	1271	1247	1483	30
	75	695	870	914	1119	1102	1330	1301	1555	1525	1810	36
	80	870	1088	1105	1350	1320	1590	1553	1852	1817	2152	42
75	75	592	734	770	936	926	1111	1091	1298	1278	1511	30
	80	747	926	940	1142	1120	1343	1317	1564	1540	1817	35
80	80	639	785	799	964	951	1133	1116	1320	1305	1534	30

TABLE 31.--CURRENT AND PROJECTED MERCHANTABLE CUBIC FOOT VOLUME(V101,V100) AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX 50		60		70		80		90		PROJECTED BASAL AREA
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
40 SQ. FT. INITIAL BASAL AREA												
20	20	0	0	1	1	6	8	23	32	64	88	40
	25	1	1	7	9	34	45	110	146	265	353	64
	30	3	4	25	33	109	143	311	406	665	867	88
	35	10	13	68	88	258	332	654	841	1260	1616	110
	40	25	32	150	191	500	636	1140	1447	2009	2542	131
	45	54	69	283	358	845	1065	1747	2197	2859	3580	149
	50	103	131	481	605	1282	1617	2448	3052	3763	4669	166
25	25	1	1	6	8	31	41	97	131	225	301	40
	30	3	4	27	36	113	149	306	403	611	802	59
	35	12	15	80	104	287	373	674	875	1196	1544	79
	40	32	41	184	237	573	737	1190	1524	1921	2446	97
	45	71	32	356	456	972	1240	1814	2301	2724	3429	115
	50	140	181	608	775	1468	1859	2505	3149	3559	4438	131
	55	250	320	943	1198	2036	2561	3226	4024	4394	5434	146
30	30	3	4	25	33	101	134	261	345	495	650	40
	35	12	16	81	106	275	359	604	787	1006	1301	56
	40	36	46	196	255	568	735	1088	1400	1647	2100	72
	45	83	109	390	505	974	1250	1669	2124	2359	2973	88
	50	169	219	672	864	1466	1867	2302	2902	3101	3871	103
	55	303	393	1037	1326	2012	2544	2955	3695	3847	4762	117
	60	498	643	1469	1870	2583	3245	3607	4476	4578	5626	131
35	35	12	15	74	97	239	313	498	649	792	1023	40
	40	35	47	189	246	512	665	921	1185	1332	1696	54
	45	88	115	387	503	891	1146	1432	1822	1943	2447	68
	50	184	240	674	871	1346	1718	1991	2510	2591	3231	81
	55	335	437	1038	1334	1845	2336	2570	3213	3251	4021	95
	60	552	717	1458	1863	2361	2970	3151	3911	3908	4799	107
	65	834	1080	1911	2428	2878	3597	3723	4590	4552	5555	119
40	40	34	44	169	221	434	563	744	955	1043	1325	40
	45	87	114	358	465	770	990	1179	1498	1558	1957	52
	50	186	243	631	816	1173	1496	1663	2093	2116	2634	64
	55	344	450	974	1252	1616	2045	2171	2711	2696	3330	76
	60	569	742	1363	1743	2076	2609	2688	3332	3284	4028	88
	65	855	1112	1777	2260	2538	3169	3203	3944	3869	4716	100
	70	1191	1544	2198	2779	2994	3716	3709	4541	4444	5388	110
45	45	80	105	314	407	641	821	949	1201	1231	1541	40
	50	177	232	562	726	990	1260	1362	1709	1707	2119	51
	55	334	437	873	1122	1377	1739	1804	2247	2213	2728	62
	60	555	725	1225	1565	1783	2236	2261	2798	2736	3350	72
	65	833	1084	1597	2028	2195	2736	2724	3349	3265	3973	83
	70	1152	1494	1974	2494	2605	3229	3184	3894	3792	4591	93
	75	1496	1931	2349	2951	3010	3710	3639	4427	4313	5196	103
50	50	162	212	485	624	819	1037	1102	1378	1367	1691	40
	55	311	406	760	974	1153	1452	1485	1843	1806	2220	50
	60	520	678	1072	1366	1509	1838	1887	2329	2268	2770	59
	65	780	1014	1403	1777	1875	2332	2301	2823	2743	3332	69
	70	1076	1392	1740	2193	2245	2776	2719	3318	3224	3896	79
	75	1390	1792	2077	2604	2614	3216	3136	3809	3704	4457	88
	80	1710	2194	2409	3005	2977	3646	3550	4292	4181	5008	97
55	55	280	364	648	826	955	1197	1214	1502	1468	1798	40
	60	473	614	922	1169	1265	1578	1567	1927	1874	2283	49
	65	711	921	1214	1533	1591	1972	1936	2368	2299	2787	58
	70	979	1264	1515	1903	1923	2372	2314	2817	2735	3299	66
	75	1263	1624	1818	2273	2258	2772	2696	3267	3176	3815	75
	80	1552	1986	2120	2638	2592	3168	3078	3715	3618	4327	84
60	60	420	542	783	988	1056	1310	1297	1589	1546	1877	40
	65	634	817	1040	1307	1343	1658	1624	1981	1924	2325	48
	70	875	1125	1308	1637	1640	2017	1964	2385	2317	2789	56
	75	1131	1448	1581	1970	1944	2380	2312	2797	2720	3260	64
	80	1391	1773	1855	2302	2251	2745	2664	3210	3127	3735	72
65	65	557	713	885	1106	1129	1389	1360	1653	1608	1938	40
	70	772	987	1123	1399	1396	1709	1665	2016	1961	2354	47
	75	1001	1275	1368	1698	1671	2039	1981	2390	2327	2784	55
	80	1235	1568	1618	2000	1951	2373	2304	2770	2702	3220	62
70	70	674	856	960	1190	1165	1445	1410	1701	1659	1985	40
	75	878	1113	1180	1458	1433	1743	1696	2040	1990	2375	47
	80	1089	1375	1407	1732	1689	2048	1991	2388	2333	2775	54
75	75	767	965	1016	1249	1228	1487	1451	1739	1702	2024	40
	80	956	1200	1221	1497	1461	1765	1720	2056	2014	2389	46
80	80	835	1042	1058	1291	1263	1520	1485	1770	1738	2056	40

TABLE 32.--CURRENT AND PROJECTED MERCHANTABLE CUBIC FOOT VOLUME(V101,V100) AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX										PROJECTED BASAL AREA
		50		60		70		80		90		
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
50 SQ. FT. INITIAL BASAL AREA												
20	20	0	0	1	1	6	9	25	34	70	95	50
	25	1	1	6	9	33	44	109	145	268	355	77
	30	3	4	23	30	102	133	297	386	652	846	102
	35	9	11	61	79	236	302	614	785	1223	1563	126
	40	22	28	132	167	452	572	1067	1348	1953	2461	146
	45	46	59	248	312	764	958	1645	2058	2796	3488	165
	50	89	112	422	527	1177	1464	2327	2887	3711	4588	181
25	25	1	1	7	9	33	44	105	141	248	332	50
	30	3	4	27	35	114	149	315	414	649	850	72
	35	11	14	76	98	279	361	679	878	1250	1610	92
	40	29	37	170	219	549	703	1190	1520	1997	2538	112
	45	64	82	326	415	929	1180	1817	2297	2831	3558	130
	50	124	158	555	703	1410	1777	2521	3160	3704	4611	146
	55	219	279	865	1090	1971	2459	3266	4063	4581	5657	161
30	30	3	4	27	35	109	144	289	382	564	741	50
	35	12	16	81	106	285	372	651	847	1122	1449	68
	40	34	44	192	249	579	747	1159	1488	1814	2312	86
	45	77	100	376	484	985	1262	1769	2248	2580	3251	102
	50	154	199	644	825	1485	1888	2439	3071	3376	4213	118
	55	275	355	997	1269	2049	2585	3132	3912	4171	5163	133
	60	452	580	1423	1803	2646	3317	3925	4743	4949	6081	146
35	35	12	16	79	104	264	346	570	742	933	1205	50
	40	36	47	195	255	553	717	1035	1332	1539	1962	65
	45	86	112	393	509	952	1224	1593	2028	2217	2794	81
	50	175	228	679	875	1434	1829	2202	2777	2927	3653	95
	55	317	411	1047	1341	1966	2488	2830	3539	3642	4508	109
	60	521	674	1478	1884	2520	3167	3457	4291	4348	5343	122
	65	780	1020	1950	2473	3075	3841	4070	5019	5034	6146	135
40	40	36	47	185	241	494	641	877	1127	1257	1599	50
	45	88	116	382	496	863	1111	1359	1741	1844	2320	63
	50	185	242	667	862	1306	1667	1909	2406	2468	3077	77
	55	340	443	1027	1320	1791	2269	2470	3088	3108	3843	90
	60	559	728	1441	1841	2294	2885	3035	3766	3747	4601	102
	65	844	1095	1885	2395	2797	3495	3592	4428	4377	5340	114
	70	1184	1531	2339	2957	3291	4087	4135	5068	4990	6054	126
45	45	86	113	352	457	750	964	1142	1450	1504	1889	50
	50	185	242	621	804	1145	1460	1615	2032	2049	2550	62
	55	344	450	960	1235	1579	1998	2113	2637	2618	3232	74
	60	569	742	1344	1719	2031	2551	2620	3246	3195	3918	86
	65	855	1111	1752	2227	2485	3102	3126	3849	3771	4596	97
	70	1189	1541	2166	2738	2933	3540	3625	4438	4339	5259	108
	75	1554	2006	2576	3239	3371	4161	4112	5008	4895	5903	118
50	50	177	231	558	720	980	1246	1346	1688	1685	2092	50
	55	333	436	867	1114	1363	1722	1784	2222	2187	2695	61
	60	554	723	1216	1553	1766	2215	2238	2768	2706	3313	72
	65	831	1081	1535	2013	2175	2711	2697	3316	3232	3933	82
	70	1149	1483	1951	2476	2593	3201	3155	3658	3756	4547	92
	75	1491	1924	2333	2930	2985	3680	3508	4388	4275	5150	102
	80	1842	2367	2697	3370	3379	4144	4051	4904	4783	5737	112
55	55	312	407	764	979	1161	1461	1495	1857	1819	2236	50
	60	522	680	1077	1373	1518	1899	1899	2344	2283	2789	60
	65	783	1017	1409	1786	1806	2346	2315	2840	2760	3353	70
	70	1079	1397	1748	2203	2257	2792	2734	3337	3243	3919	79
	75	1394	1797	2097	2616	2627	3232	3153	3830	3725	4481	89
	80	1716	2201	2420	3019	2992	3664	3567	4314	4202	5034	98
60	60	479	622	941	1194	1296	1615	1605	1976	1922	2342	50
	65	720	933	1238	1563	1625	2016	1980	2423	2353	2852	59
	70	992	1281	1543	1940	1962	2421	2353	2878	2734	3371	68
	75	1280	1646	1851	2315	2302	2826	2749	3334	3240	3893	77
	80	1573	2014	2156	2684	2640	3227	3135	3786	3696	4410	86
65	65	651	841	1077	1356	1395	1724	1689	2052	2002	2422	50
	70	899	1156	1352	1694	1700	2092	2038	2476	2405	2896	58
	75	1160	1487	1632	2035	2011	2463	2393	2896	2816	3377	67
	80	1427	1821	1912	2374	2324	2835	2752	3317	3231	3860	75
70	70	804	1030	1179	1471	1469	1802	1755	2127	2068	2485	50
	75	1041	1329	1433	1781	1754	2142	2081	2513	2446	2927	58
	80	1283	1632	1690	2092	2042	2486	2413	2903	2831	3376	65
75	75	928	1178	1255	1553	1527	1860	1808	2178	2123	2536	50
	80	1148	1453	1490	1839	1793	2176	2115	2539	2479	2951	57
80	80	1021	1287	1312	1612	1573	1903	1853	2218	2170	2578	50

TABLE 33.--CURRENT AND PROJECTED MERCHANTABLE CUBIC FOOT VOLUME(V101,V100) AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX 50		60		70		80		90		PROJECTED BASAL AREA
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
		60 SQ. FT. INITIAL BASAL AREA										
20	20	0	0	1	1	7	9	26	34	72	98	60
	25	1	1	6	8	32	42	106	139	262	346	89
	30	2	3	21	28	94	122	278	359	623	806	116
	35	8	10	55	70	213	271	568	722	1163	1478	139
	40	19	24	117	147	405	511	936	1238	1861	2336	160
	45	40	51	218	273	683	857	1529	1902	2686	3336	179
	50	77	97	372	462	1066	1319	2184	2695	3597	4431	195
25	25	1	1	7	9	34	45	109	146	262	349	60
	30	3	4	26	34	111	145	314	411	664	867	83
	35	10	13	71	91	265	342	665	856	1264	1623	105
	40	23	33	156	199	516	658	1159	1475	2015	2554	125
	45	56	72	295	375	872	1101	1775	2235	2863	3589	144
	50	109	139	503	633	1329	1668	2479	3096	3760	4671	160
	55	193	244	786	936	1875	2339	3236	4013	4670	5756	175
30	30	3	4	27	36	113	149	307	404	614	806	60
	35	12	15	80	104	286	372	675	876	1200	1549	79
	40	32	41	183	236	572	735	1191	1525	1926	2452	98
	45	71	92	355	454	970	1238	1816	2302	2732	3439	116
	50	140	180	606	771	1466	1856	2508	3152	3569	4450	132
	55	248	318	940	1191	2034	2558	3230	4029	4406	5449	147
	60	407	520	1351	1705	2646	3308	3957	4900	5223	6413	160
35	35	12	16	81	106	280	365	622	810	1048	1354	60
	40	35	46	195	254	574	743	1116	1435	1708	2177	77
	45	82	106	387	499	922	1259	1708	2173	2439	3074	93
	50	164	212	665	854	1478	1831	2355	2968	3200	3995	108
	55	294	380	1027	1311	2031	2566	3022	3778	3963	4906	123
	60	483	623	1458	1853	2612	3279	3688	4577	4710	5788	136
	65	736	947	1939	2453	3199	3992	4337	5348	5433	6633	149
40	40	36	47	193	252	537	696	986	1269	1447	1844	60
	45	87	114	392	509	928	1194	1524	1940	2096	2640	75
	50	180	234	680	877	1399	1785	2111	2652	2778	3466	89
	55	326	424	1047	1343	1917	2427	2717	3398	3468	4292	103
	60	536	696	1474	1681	2454	3086	3324	4126	4152	5101	116
	65	912	1051	1939	2461	2993	3739	3918	4832	4819	5883	128
	70	1148	1461	2419	3056	3520	4372	4493	5509	5465	6633	139
45	45	88	116	376	489	838	1078	1314	1671	1760	2213	60
	50	186	243	659	851	1270	1621	1838	2316	2365	2947	73
	55	342	446	1015	1305	1743	2208	2384	2980	2987	3693	86
	60	564	734	1422	1818	2233	2808	2935	3641	3612	4434	98
	65	850	1104	1853	2362	2725	3404	3400	4289	4228	5158	110
	70	1190	1540	2303	2912	3207	3983	4012	4916	4831	5860	121
	75	1569	2023	2744	3452	3675	4539	4528	5518	5415	6535	132
50	50	184	241	613	792	1120	1428	1572	1977	1990	2476	60
	55	343	449	947	1218	1546	1956	2061	2571	2549	3146	72
	60	568	741	1326	1696	1990	2500	2560	3171	3117	3821	83
	65	853	1109	1728	2197	2437	3042	3059	3765	3685	4490	94
	70	1185	1536	2136	2700	2890	3573	3551	4347	4247	5146	105
	75	1547	1998	2540	3194	3312	4087	4033	4911	4797	5784	116
	80	1924	2473	2934	3669	3731	4581	4501	5455	5332	6400	125
55	55	332	434	860	1105	1349	1704	1764	2196	2161	2663	60
	60	552	720	1207	1542	1749	2193	2214	2738	2676	3276	71
	65	828	1077	1574	1998	2155	2686	2670	3283	3198	3892	81
	70	1145	1484	1947	2458	2561	3173	3126	3821	3720	4503	91
	75	1485	1917	2317	2909	2961	3649	3576	4349	4236	5103	101
	80	1834	2357	2679	3347	3352	4111	4017	4863	4743	5688	111
60	60	523	681	1080	1376	1523	1905	1905	2351	2291	2799	60
	65	784	1018	1413	1790	1891	2352	2322	2849	2769	3364	70
	70	1080	1399	1752	2209	2263	2779	2742	3347	3252	3930	79
	75	1396	1800	2091	2622	2633	3240	3161	3840	3734	4493	89
	80	1718	2205	2425	3025	2999	3672	3576	4324	4212	5046	98
65	65	727	943	1255	1586	1651	2048	2012	2464	2392	2901	60
	70	1002	1294	1564	1966	1991	2458	2399	2923	2838	3425	69
	75	1293	1663	1875	2345	2334	2866	2769	3382	3288	3950	78
	80	1588	2034	2183	2718	2675	3270	3178	3838	3737	4472	87
70	70	917	1180	1387	1739	1747	2151	2096	2548	2474	2980	60
	75	1183	1517	1672	2086	2063	2529	2457	2974	2892	3469	68
	80	1454	1857	1957	2430	2381	2906	2821	3401	3313	3959	77
75	75	1073	1372	1486	1848	1821	2226	2163	2613	2542	3044	60
	80	1322	1683	1749	2166	2116	2577	2502	3011	2935	3502	68
80	80	1195	1515	1559	1926	1879	2283	2218	2664	2600	3097	60

TABLE 34.--CURRENT AND PROJECTED MERCHANTABLE CUBIC FOOT VOLUME(V101,V100) AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX										PROJECTED BASAL AREA
		50		60		70		80		90		
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
70 SQ. FT. INITIAL BASAL AREA												
20	20	0	0	1	1	7	9	26	34	72	88	70
	25	1	1	6	8	30	39	100	131	252	331	101
	30	2	3	19	25	85	111	257	330	587	755	128
	35	7	9	49	62	192	243	520	639	1090	1379	152
	40	17	21	103	129	364	456	903	1129	1751	2188	173
	45	35	44	192	239	618	766	1410	1746	2548	3151	191
	50	67	84	329	406	905	1187	2034	2499	3446	4228	207
25	25	1	1	7	9	34	45	110	146	268	356	70
	30	3	4	25	32	106	138	306	398	662	861	95
	35	9	12	65	84	249	318	638	818	1248	1597	117
	40	23	30	141	180	478	607	1109	1404	1989	2513	138
	45	50	64	266	336	808	1016	1704	2137	2838	3548	157
	50	95	122	453	568	1240	1548	2397	2933	3749	4645	173
	55	170	215	712	889	1764	2190	3157	3901	4683	5759	188
30	30	3	4	27	35	114	150	315	413	646	846	70
	35	11	14	77	99	280	363	680	879	1246	1605	91
	40	29	38	172	221	553	708	1192	1523	1991	2531	110
	45	65	83	330	421	935	1183	1819	2301	2822	3548	128
	50	126	161	562	713	1419	1789	2523	3163	3691	4596	144
	55	223	284	875	1104	1992	2494	3266	4064	4563	5637	159
	60	366	465	1268	1593	2200	3240	4019	4969	5416	6644	173
35	35	12	16	81	106	266	373	657	854	1138	1470	70
	40	33	44	191	247	579	747	1167	1499	1837	2342	88
	45	76	99	373	479	985	1260	1781	2263	2612	3291	105
	50	152	196	638	816	1465	1885	2455	3091	3415	4262	121
	55	271	348	937	1255	2050	2594	3155	3939	4219	5221	135
	60	444	570	1411	1737	2650	3321	3654	4778	5004	6147	149
	65	679	870	1893	2387	3263	4065	4536	5539	5760	7031	161
40	40	36	47	196	255	564	730	1072	1379	1612	2055	70
	45	84	110	392	507	958	1243	1645	2094	2313	2915	86
	50	171	222	676	869	1457	1886	2271	2863	3045	3800	101
	55	308	399	1042	1333	1998	2528	2916	3646	3780	4679	115
	60	506	654	1474	1876	2564	3222	3559	4417	4503	5534	128
	65	769	991	1950	2471	3133	3912	4187	5163	5204	6355	140
	70	1095	1408	2451	3091	3691	4582	4792	5875	5878	7136	152
45	45	88	115	389	505	904	1163	1463	1862	1994	2512	70
	50	182	238	677	874	1365	1742	2032	2562	2653	3310	84
	55	333	433	1042	1338	1870	2368	2620	3276	3324	4112	97
	60	547	711	1465	1871	2394	3011	3210	3984	3990	4901	110
	65	927	1071	1922	2441	2918	3646	3769	4672	4642	5665	122
	70	1195	1523	2392	3023	3432	4263	4351	5334	5274	6400	134
	75	1550	1996	2861	3598	3928	4852	4892	5965	5883	7103	144
50	50	186	244	650	841	1230	1580	1780	2242	2231	2841	70
	55	344	449	1003	1239	1702	2155	2313	2890	2689	3570	83
	60	567	738	1404	1796	2182	2743	2852	3538	3501	4296	95
	65	853	1109	1833	2331	2663	3327	3387	4173	4107	5009	106
	70	1192	1544	2270	2871	3137	3895	3910	4790	4700	5700	117
	75	1559	2027	2703	3400	3597	4441	4418	5384	5277	6367	128
	90	1964	2524	3124	3910	4040	4963	4909	5952	5834	7007	138
55	55	342	448	936	1204	1519	1921	2018	2518	2492	3076	70
	60	567	739	1311	1676	1956	2457	2510	3109	3053	3742	81
	65	851	1107	1708	2171	2398	2992	3003	3697	3615	4404	92
	70	1181	1531	2111	2668	2835	3517	3491	4272	4171	5054	103
	75	1541	1930	2510	3156	3263	4025	3958	4831	4716	5696	113
	80	1914	2460	2899	3626	3678	4515	4432	5371	5247	6298	123
60	60	551	719	1200	1532	1735	2176	2195	2714	2652	3246	70
	65	826	1074	1564	1986	2139	2666	2649	3256	3172	3859	80
	70	1141	1480	1935	2443	2543	3150	3102	3792	3691	4468	91
	75	1480	1911	2304	2893	2941	3624	3550	4318	4205	5065	101
	80	1828	2349	2664	3328	3330	4084	3990	4830	4710	5648	110
65	65	795	1020	1416	1794	1896	2359	2328	2857	2776	3373	70
	70	1062	1401	1756	2213	2269	2806	2749	3355	3260	3941	80
	75	1398	1802	2096	2628	2640	3248	3169	3849	3744	4504	89
	80	1721	2208	2430	3032	3005	3681	3584	4334	4222	5058	98
70	70	1010	1305	1582	1989	2017	2490	2431	2962	2876	3472	70
	75	1303	1677	1895	2372	2362	2902	2824	3425	3329	4001	79
	80	1602	2051	2206	2747	2705	3308	3215	3883	3781	4525	88
75	75	1203	1543	1707	2130	2109	2586	2513	3043	2958	3550	70
	80	1478	1888	1995	2480	2430	2367	2881	3475	3384	4045	78
80	80	1355	1727	1800	2232	2181	2658	2580	3107	3027	3614	70

TABLE 35.--CURRENT AND PROJECTED MERCHANTABLE CUBIC FOOT VOLUME(V10I,V10O) AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX										PROJECTED BASAL AREA
		50		60		70		80		90		
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
		80 SQ. FT. INITIAL BASAL AREA										
20	20	0	0	1	1	6	9	25	33	71	96	80
	25	0	1	5	7	28	36	94	122	238	311	112
	30	2	3	18	22	78	100	236	302	546	699	140
	35	6	8	44	55	173	217	474	593	1011	1274	164
	40	15	18	91	114	327	407	824	1025	1633	2032	185
	45	31	39	171	211	556	686	1295	1595	2397	2951	203
	50	59	74	292	360	873	1069	1885	2305	3275	4001	219
25	25	1	1	6	8	33	43	109	144	267	354	80
	30	3	3	23	30	100	130	293	379	646	837	106
	35	8	11	60	76	230	294	603	769	1209	1543	129
	40	21	27	128	162	440	556	1046	1320	1931	2432	150
	45	45	56	240	301	744	931	1616	2018	2771	3453	169
	50	85	108	408	509	1147	1425	2291	2839	3686	4553	185
	55	151	189	644	800	1647	2035	3045	3749	4636	5686	200
30	30	3	4	26	34	112	147	315	413	662	865	80
	35	10	13	72	93	269	348	670	864	1263	1624	102
	40	27	34	150	205	526	671	1170	1490	2015	2556	122
	45	58	75	304	386	888	1124	1790	2257	2861	3539	140
	50	113	144	517	653	1353	1700	2495	3119	3752	4664	156
	55	200	254	808	1015	1905	2378	3350	4034	4653	5739	171
	60	329	416	1179	1475	2521	3130	4025	4965	5539	6785	185
35	35	12	15	80	104	286	372	676	876	1203	1552	80
	40	32	41	183	236	571	735	1191	1526	1931	2458	99
	45	71	91	353	453	959	1236	1817	2304	2737	3446	116
	50	139	179	603	769	1464	1853	2510	3154	3576	4459	132
	55	247	316	937	1187	2032	2555	3234	4032	4415	5460	147
	60	405	518	1347	1700	2645	3306	3951	4906	5234	6427	161
	65	623	734	1823	2291	3277	4074	4675	5753	6022	7348	174
40	40	35	45	194	252	577	746	1134	1457	1750	2231	80
	45	80	104	383	494	985	1263	1734	2205	2495	3145	96
	50	160	208	658	844	1483	1887	2390	3011	3270	4081	112
	55	267	371	1017	1297	2041	2577	3067	3833	4045	5007	126
	60	472	607	1446	1836	2629	3298	3743	4644	4804	5903	140
	65	720	924	1928	2438	3224	4021	4403	5427	5536	6760	153
	70	1032	1322	2442	3073	3810	4726	5037	6174	6237	7572	164
45	45	86	112	393	509	950	1222	1587	2020	2206	2780	80
	50	176	229	680	876	1431	1825	2194	2766	2913	3635	95
	55	318	413	1047	1342	1962	2483	2820	3526	3626	4488	109
	60	522	676	1479	1884	2514	3160	3445	4276	4330	5320	122
	65	792	1023	1949	2472	3068	3832	4056	5002	5014	6121	134
	70	1124	1448	2440	3030	3610	4483	4646	5696	5673	6887	146
	75	1508	1937	2934	3665	4134	5106	5211	6355	6305	7614	156
50	50	184	240	672	868	1334	1703	1966	2478	2553	3183	80
	55	337	439	1035	1330	1829	2316	2539	3175	3206	3966	93
	60	554	721	1453	1857	2341	2944	3116	3866	3858	4738	106
	65	837	1095	1903	2419	2854	3566	3683	4541	4498	5489	118
	70	1177	1521	2365	2990	3356	4169	4234	5190	5120	6212	129
	75	1560	2010	2825	3552	3842	4746	4766	5811	5720	6905	140
	80	1970	2529	3272	4095	4309	5296	5277	6402	6297	7566	150
55	55	344	450	992	1275	1668	2111	2256	2818	2811	3473	80
	60	568	740	1389	1776	2140	2690	2786	3455	3413	4187	92
	65	855	1111	1811	2303	2613	3264	3313	4081	4010	4890	104
	70	1193	1545	2242	2835	3080	3923	3829	4690	4597	5574	115
	75	1566	2021	2669	3356	3533	4362	4331	5277	5167	6234	125
	80	1958	2517	3083	3858	3971	4878	4816	5840	5720	6869	135
60	60	566	738	1299	1660	1931	2424	2472	3062	3005	3682	80
	65	849	1105	1692	2150	2368	2954	2961	3644	3562	4338	91
	70	1178	1527	2091	2643	2801	3474	3444	4215	4113	4983	102
	75	1535	1983	2487	3126	3225	3978	3918	4770	4655	5612	112
	80	1905	2449	2872	3592	3637	4464	4380	5306	5183	6220	122
65	65	824	1073	1558	1978	2129	2652	2635	3239	3154	3838	80
	70	1139	1477	1928	2434	2531	3136	3087	3773	3672	4445	90
	75	1477	1907	2295	2882	2928	3608	3534	4298	4185	5041	100
	80	1824	2343	2654	3315	3317	4067	3972	4809	4689	5623	110
70	70	1084	1403	1762	2221	2277	2817	2760	3369	3274	3957	80
	75	1401	1806	2103	2636	2649	3260	3181	3864	3758	4522	89
	80	1724	2213	2438	3041	3015	3693	3597	4350	4237	5077	99
75	75	1314	1690	1916	2398	2390	2937	2859	3468	3371	4051	80
	80	1614	2068	2229	2776	2736	3346	3253	3929	3826	4579	89
80	80	1500	1918	2032	2526	2478	3026	2939	3545	3453	4128	80

TABLE 36.--CURRENT AND PROJECTED MERCHANTABLE CUBIC FOOT VOLUME(VI01,VI00) AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX 50 I.B.	50 O.B.	60 I.B.	60 O.B.	70 I.B.	70 O.B.	80 I.B.	80 O.B.	90 I.B.	90 O.B.	PROJECTED BASAL AREA
YEARS												SQ. FT.
						90 SQ. FT. INITIAL BASAL AREA						
20	20	0	0	1	1	6	8	24	32	69	92	90
	25	0	1	5	6	26	33	87	113	222	289	123
	30	2	2	16	20	71	90	215	274	504	642	151
	35	5	7	39	49	155	194	430	539	932	1169	176
	40	13	16	81	101	293	363	750	928	1514	1875	196
	45	27	34	152	187	500	614	1186	1454	2241	2748	214
	50	52	65	251	320	791	964	1742	2121	3093	3764	229
25	25	1	1	6	8	32	42	105	138	262	345	90
	30	2	3	21	27	94	121	276	357	620	801	117
	35	8	10	54	69	211	269	563	716	1156	1470	141
	40	19	24	115	145	402	506	978	1222	1851	2323	162
	45	40	50	215	269	681	848	1518	1888	2673	3320	180
	50	76	95	367	456	1056	1306	2170	2678	3584	4413	196
	55	134	168	583	720	1529	1901	2911	3570	4544	5557	211
30	30	3	4	25	33	109	141	310	404	665	866	90
	35	10	12	68	87	255	328	650	835	1257	1612	112
	40	24	31	147	188	494	628	1131	1436	2004	2536	133
	45	53	67	278	352	835	1052	1736	2181	2854	3573	151
	50	101	129	473	594	1277	1598	2434	3034	3761	4665	168
	55	179	226	742	928	1811	2252	3194	3953	4685	5763	183
	60	295	372	1091	1356	2419	2993	3984	4902	5601	6849	196
35	35	11	14	77	100	281	364	680	880	1244	1603	90
	40	29	38	173	222	554	710	1193	1524	1988	2528	109
	45	65	84	331	423	938	1192	1820	2302	2818	3543	127
	50	127	162	565	716	1422	1794	2523	3164	3685	4590	144
	55	224	286	879	1109	1936	2489	3265	4064	4555	5628	159
	60	368	469	1273	1600	2603	3245	4017	4967	5407	6633	172
	65	568	721	1737	2175	3250	4031	4759	5849	6226	7590	185
40	40	33	43	189	245	578	746	1174	1506	1859	2369	90
	45	75	97	369	474	983	1257	1791	2275	2641	3327	107
	50	149	192	632	807	1483	1882	2470	3108	3452	4307	123
	55	266	342	978	1243	2049	2582	3175	3963	4263	5275	138
	60	436	559	1400	1771	2653	3322	3880	4810	5055	6210	151
	65	668	854	1881	2370	3270	4072	4569	5628	5818	7101	164
	70	964	1231	2401	3015	3891	4808	5231	6408	6545	7943	176
45	45	83	108	389	503	977	1254	1685	2144	2391	3014	90
	50	167	216	670	861	1471	1873	2324	2929	3141	3921	105
	55	300	388	1033	1321	2020	2554	2983	3729	3893	4819	120
	60	492	635	1465	1864	2596	3259	3640	4517	4631	5691	133
	65	750	965	1945	2452	3176	3963	4281	5278	5345	6527	145
	70	1071	1375	2451	3089	3745	4648	4898	6004	6030	7321	157
	75	1448	1855	2966	3721	4295	5303	5487	6691	6683	8071	168
50	50	179	233	680	877	1406	1794	2128	2683	2804	3500	90
	55	325	422	1048	1344	1926	2439	2738	3424	3500	4331	104
	60	534	692	1476	1883	2467	3102	3348	4156	4187	5145	117
	65	809	1046	1941	2464	3008	3758	3946	4866	4858	5931	129
	70	1144	1475	2424	3062	3539	4395	4524	5546	5506	6683	141
	75	1529	1965	2908	3655	4050	5003	5079	6194	6128	7400	151
	80	1947	2495	3380	4228	4539	5580	5609	6807	6723	8079	162
55	55	339	443	1028	1321	1794	2272	2474	3093	3114	3851	90
	60	559	727	1442	1842	2297	2883	3040	3772	3754	4609	102
	65	844	1094	1836	2397	2800	3499	3598	4435	4384	5349	114
	70	1184	1531	2341	2959	3294	4092	4141	5075	4997	6063	126
	75	1565	2018	2792	3512	3773	4660	4666	5668	5591	6748	136
	80	1971	2532	3232	4045	4232	5201	5171	6272	6162	7403	147
60	60	569	741	1376	1759	2107	2648	2735	3391	3346	4105	90
	65	855	1112	1794	2281	2575	3215	3256	4011	3937	4800	101
	70	1193	1545	2220	2807	3036	3768	3767	4613	4518	5477	112
	75	1564	2016	2641	3322	3484	4301	4264	5195	5084	6133	123
	80	1952	2509	3051	3818	3917	4812	4746	5754	5632	6763	133
65	65	848	1103	1681	2136	2346	2927	2931	3607	3524	4293	90
	70	1175	1524	2077	2625	2777	3444	3412	4175	4073	4934	101
	75	1531	1977	2470	3105	3199	3945	3883	4727	4612	5560	111
	80	1899	2441	2853	3569	3608	4429	4343	5262	5138	6166	121
70	70	1138	1476	1925	2430	2527	3130	3081	3766	3665	4436	90
	75	1476	1905	2292	2877	2923	3602	3528	4290	4178	5032	100
	80	1822	2341	2650	3311	3311	4061	3966	4801	4681	5613	109
75	75	1405	1812	2113	2649	2663	3278	3199	3886	3780	4548	90
	80	1730	2220	2449	3055	3031	3713	3616	4373	4260	5104	99
80	80	1628	2086	2254	2808	2769	3388	3294	3979	3875	4638	90

TABLE 37.--CURRENT AND PROJECTED MERCHANTABLE CUBIC FOOT VOLUME(V101,V100) AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX 50		60		70		80		90		PROJECTED BASAL AREA
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
		100 SQ. FT. INITIAL BASAL AREA										
20	20	0	0	1	1	6	8	23	30	65	87	100
	25	0	1	5	5	24	30	80	103	206	267	134
	30	2	2	14	18	64	81	195	247	462	587	162
	35	5	6	35	43	139	173	389	486	856	1068	186
	40	11	14	72	90	263	324	681	839	1397	1723	207
	45	24	30	136	166	451	551	1095	1324	2087	2547	224
	50	47	58	234	286	718	871	1608	1948	2910	3526	239
25	25	1	1	6	8	30	39	100	132	252	332	100
	30	2	3	20	25	87	111	258	332	589	757	127
	35	7	9	49	62	193	244	522	661	1093	1384	152
	40	17	21	104	130	366	458	907	1134	1757	2196	173
	45	35	44	194	241	621	771	1416	1753	2555	3160	191
	50	68	85	331	409	989	1193	2041	2508	3454	4238	207
	55	120	149	527	649	1415	1732	2764	3377	4417	5395	221
30	30	3	4	24	31	104	134	300	390	655	851	100
	35	9	11	63	80	240	307	622	795	1232	1574	123
	40	22	28	135	171	460	592	1080	1365	1965	2479	144
	45	47	60	253	319	778	975	1684	2083	2811	3509	162
	50	91	115	431	539	1196	1469	2349	2917	3724	4608	179
	55	161	202	679	845	1709	2116	3107	3833	4657	5732	194
	60	265	333	1005	1246	2303	2839	3906	4792	5508	6845	207
35	35	10	14	73	94	271	350	673	869	1262	1623	100
	40	27	35	162	207	530	677	1175	1497	2014	2555	120
	45	59	76	309	391	886	1135	1796	2266	2869	3587	138
	50	115	147	524	662	1384	1715	2522	3129	3746	4658	155
	55	203	258	819	1028	1910	2355	3255	4042	4643	5729	170
	60	334	423	1193	1493	2534	3149	4028	4970	5505	6769	183
	65	517	654	1672	2043	3183	3944	4794	5932	6374	7763	196
40	40	31	41	182	234	569	732	1193	1527	1940	2469	100
	45	70	90	351	449	966	1231	1819	2306	2750	3461	118
	50	137	177	609	762	1460	1847	2513	3158	3592	4479	134
	55	244	312	930	1178	2028	2549	3240	4039	4435	5485	149
	60	401	511	1339	1699	2641	3301	3971	4917	5259	6456	162
	65	616	784	1813	2279	3276	4071	4658	5769	6051	7382	175
	70	895	1139	2336	2924	3910	4885	5379	6622	6804	8254	186
45	45	79	102	379	498	996	1263	1757	2233	2549	3212	100
	50	157	202	650	833	1496	1888	2421	3049	3336	4164	116
	55	290	361	1005	1281	2047	2583	3109	3984	4124	5104	130
	60	460	591	1432	1817	2641	3312	3795	4707	4894	6014	144
	65	702	900	1915	2418	3244	4044	4464	5502	5637	6882	156
	70	1010	1292	2431	3058	3939	4960	5108	6260	6347	7704	168
	75	1377	1733	2983	3711	4415	5447	5722	6975	7021	8478	179
50	50	171	223	676	870	1455	1854	2264	2854	3033	3786	100
	55	309	400	1042	1334	1935	2524	2907	3635	3766	4662	114
	60	509	656	1474	1877	2560	3217	3549	4405	4488	5515	127
	65	771	994	1951	2472	3128	3905	4175	5149	5187	6334	140
	70	1098	1412	2450	3090	3684	4674	4779	5859	5860	7114	152
	75	1479	1897	2955	3710	4221	5213	5357	6532	6502	7853	162
	80	1901	2432	3451	4313	4733	5917	5906	7168	7114	8551	173
55	55	330	429	1045	1342	1895	2400	2671	3340	3399	4206	100
	60	542	703	1471	1877	2426	3051	3269	4058	4074	5005	113
	65	820	1061	1931	2453	2958	3696	3857	4756	4734	5779	125
	70	1157	1494	2407	3042	3478	4320	4426	5425	5373	6521	137
	75	1542	1984	2893	3624	3981	4918	4973	6063	5988	7229	147
	80	1958	2511	3346	4187	4462	5485	5496	6669	6576	7903	158
60	60	562	731	1431	1830	2262	2844	2981	3699	3674	4511	100
	65	847	1100	1871	2378	2758	3446	3532	4353	4297	5242	112
	70	1188	1537	2320	2934	3246	4031	4069	4986	4904	5949	123
	75	1568	2021	2765	3479	3718	4593	4539	5593	5492	6629	134
	80	1971	2531	3200	4004	4173	5128	5089	6172	6059	7279	144
65	65	855	1112	1781	2265	2547	3180	3215	3960	3885	4736	100
	70	1192	1544	2203	2786	3004	3728	3722	4558	4462	5409	111
	75	1561	2015	2621	3296	3449	4258	4217	5137	5025	6061	121
	80	1947	2503	3027	3788	3879	4765	4695	5692	5570	6688	131
70	70	1174	1522	2069	2615	2763	3426	3393	4152	4050	4906	100
	75	1529	1974	2461	3093	3183	3926	3863	4703	4588	5530	110
	80	1895	2437	2842	3554	3592	4408	4322	5236	5113	6135	120
75	75	1477	1906	2294	2880	2927	3607	3532	4296	4183	5038	100
	80	1824	2343	2653	3314	3315	4065	3971	4807	4687	5620	110
80	80	1738	2230	2465	3076	3053	3740	3643	4407	4293	5144	100

TABLE 38.--CURRENT AND PROJECTED MERCHANTABLE CUBIC FOOT VOLUME(V101,V100) AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX										PROJECTED BASAL AREA
		50		60		70		80		90		
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
		110 SQ. FT. INITIAL BASAL AREA										
20	20	0	0	1	1	5	7	21	28	62	82	110
	25	0	0	4	5	21	28	73	94	189	245	144
	30	1	2	13	16	58	73	177	223	422	534	173
	35	4	5	31	39	125	155	352	437	783	973	197
	40	10	13	65	80	237	290	618	759	1286	1579	217
	45	22	27	122	149	407	496	992	1205	1937	2355	234
	50	42	51	211	256	652	798	1483	1789	2729	3293	249
25	25	0	1	5	7	28	37	95	124	240	315	110
	30	2	3	18	23	80	102	239	306	553	709	138
	35	6	8	44	56	176	221	481	607	1025	1292	162
	40	15	19	93	117	333	415	837	1042	1653	2058	183
	45	32	39	174	216	566	693	1314	1620	2423	2985	201
	50	60	75	298	367	888	1088	1910	2337	3304	4040	217
	55	107	133	477	585	1305	1592	2612	3178	4265	5181	231
30	30	3	3	22	29	98	126	287	371	637	825	110
	35	8	10	58	74	223	284	588	749	1191	1517	134
	40	20	25	123	155	425	536	1021	1285	1903	2393	155
	45	43	54	230	289	720	899	1579	1969	2737	3406	173
	50	82	103	392	488	1112	1379	2246	2779	3651	4505	189
	55	144	181	620	768	1602	1975	2996	3683	4606	5643	204
	60	239	298	920	1140	2179	2675	3799	4646	5570	6782	217
35	35	10	13	69	88	259	333	655	843	1261	1617	110
	40	25	32	150	192	502	638	1141	1450	2009	2544	130
	45	54	69	284	359	847	1069	1750	2201	2859	3581	149
	50	104	132	483	608	1295	1622	2451	3057	3763	4670	165
	55	184	232	757	948	1834	2282	3210	3976	4683	5767	180
	60	302	381	1111	1385	2444	3026	3997	4921	5592	6841	194
	65	470	592	1542	1916	3102	3925	4787	5861	6471	7870	206
40	40	29	38	172	221	553	709	1192	1523	1991	2531	110
	45	65	83	330	421	936	1189	1819	2301	2822	3547	128
	50	126	161	562	713	1419	1790	2523	3163	3690	4595	144
	55	223	284	875	1105	1982	2484	3256	4064	4562	5636	159
	60	366	466	1268	1594	2600	3240	4019	4969	5415	6643	173
	65	565	717	1732	2168	3247	4027	4762	5853	6236	7602	186
	70	827	1047	2251	2809	3901	4816	5480	6699	7016	8506	197
45	45	74	95	364	468	980	1252	1802	2287	2675	3369	110
	50	146	188	623	795	1479	1875	2486	3127	3496	4361	126
	55	260	333	965	1226	2046	2576	3197	3990	4316	5340	141
	60	426	545	1394	1749	2653	3320	3910	4846	5117	6285	155
	65	653	834	1853	2346	3275	4076	4607	5674	5889	7186	167
	70	945	1205	2385	2992	3894	4821	5278	6463	6623	8037	179
	75	1300	1654	2929	3661	4495	5539	5916	7208	7318	8836	189
50	50	162	210	662	849	1481	1834	2373	2990	3235	4038	110
	55	291	376	1022	1304	2036	2572	3045	3806	4004	4956	124
	60	478	615	1453	1845	2621	3289	3716	4610	4757	5845	138
	65	728	936	1934	2446	3212	4007	4370	5387	5484	6696	151
	70	1043	1337	2446	3079	3793	4706	4999	6128	6180	7503	162
	75	1417	1812	2968	3721	4355	5375	5600	6828	6843	8264	173
	80	1837	2345	3486	4353	4891	6008	6169	7486	7471	8980	183
55	55	316	409	1046	1340	1971	2495	2844	3556	3664	4535	110
	60	519	671	1477	1883	2527	3176	3473	4311	4372	5372	123
	65	797	1016	1950	2473	3084	3852	4088	5042	5060	6178	136
	70	1118	1439	2444	3084	3631	4508	4682	5740	5723	6947	147
	75	1501	1927	2940	3693	4157	5135	5251	6403	6357	7677	158
	80	1922	2460	3427	4285	4651	5728	5792	7029	6962	8368	168
60	60	547	711	1465	1871	2393	3009	3208	3982	3997	4898	110
	65	828	1072	1921	2441	2917	3645	3787	4670	4639	5662	122
	70	1165	1506	2392	3023	3430	4261	4349	5331	5271	6397	134
	75	1550	1996	2861	3597	3926	4850	4890	5962	5880	7099	144
	80	1964	2520	3318	4152	4401	5410	5408	6562	6464	7767	155
65	65	850	1103	1859	2363	2728	3408	3484	4294	4234	5165	110
	70	1190	1540	2304	2914	3210	3987	4017	4922	4837	5867	121
	75	1568	2023	2746	3454	3679	4543	4533	5524	5421	6542	132
	80	1969	2530	3175	3974	4129	5074	5029	6100	5985	7189	142
70	70	1191	1543	2193	2773	2984	3703	3695	4524	4427	5366	110
	75	1559	2013	2608	3280	3427	4230	4187	5100	4987	6015	120
	80	1944	2499	3013	3769	3855	4735	4664	5654	5531	6641	130
75	75	1528	1973	2458	3089	3179	3921	3858	4696	4581	5521	110
	80	1894	2435	2839	3550	3587	4402	4316	5228	5105	6126	120
80	80	1827	2348	2662	3326	3328	4082	3987	4827	4707	5644	110

TABLE 39.--CURRENT AND PROJECTED MERCHANTABLE CUBIC FOOT VOLUME(V10I,V10O) AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX 50		60		70		80		90		PROJECTED BASAL AREA
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
						120 SQ. FT. INITIAL BASAL AREA						
20	20	0	0	1	1	5	7	20	26	58	76	120
	25	0	0	4	5	19	25	67	85	173	223	155
	30	1	2	11	14	52	65	160	201	384	484	183
	35	4	5	28	35	112	139	318	394	714	884	207
	40	9	11	58	71	213	261	551	686	1181	1444	227
	45	19	24	109	133	369	447	907	1097	1795	2173	243
	50	38	46	190	231	594	715	1367	1643	2554	3069	257
25	25	0	1	5	7	26	34	89	115	226	295	120
	30	2	2	16	21	73	93	220	281	515	658	148
	35	6	7	40	50	[illegible]	200	441	554	954	1197	173
	40	13	17	84	104	302	374	769	953	1546	1916	193
	45	28	35	157	193	515	632	1214	1491	2283	2802	211
	50	54	67	269	330	812	991	1780	2169	3142	3828	227
	55	96	119	433	528	1204	1462	2457	2978	4094	4957	240
30	30	2	3	21	27	91	118	271	349	611	789	120
	35	7	9	53	67	206	261	551	700	1138	1444	144
	40	18	23	112	140	391	491	955	1199	1824	2286	165
	45	39	48	209	260	663	824	1337	1647	2633	3273	183
	50	73	92	355	441	1029	1271	2131	2627	3547	4363	200
	55	129	162	565	697	1494	1835	2867	3512	4509	5508	214
	60	215	263	847	1041	2051	2507	3669	4472	5491	6669	227
35	35	9	12	64	82	244	313	631	808	1241	1587	120
	40	23	29	133	176	470	[illegible]	1096	1387	1979	2499	141
	45	49	62	250	328	[illegible]	[illegible]	1686	2113	2827	3532	159
	50	94	119	443	555	1220	1521	[illegible]	[illegible]	3739	4630	176
	55	166	209	697	869	1739	2157	3135	3871	4677	5749	191
	60	274	344	1030	1278	2338	2835	3933	4828	5611	6853	204
	65	427	535	1441	[illegible]	2995	3680	4741	5792	6520	7918	216
40	40	27	35	162	207	530	677	1175	1497	2014	2555	120
	45	59	76	308	391	896	1134	1796	2266	2858	3587	138
	50	115	146	524	661	1364	1714	2501	3129	3747	4659	155
	55	203	258	819	1028	1917	2395	3235	4042	4644	5729	170
	60	334	423	1192	1492	2534	3148	4027	4963	5525	6770	183
	65	517	653	1541	2047	3189	3944	4794	5883	6375	7763	196
	70	761	959	2153	2678	3850	4753	5340	6762	7183	8701	207
45	45	69	89	346	443	960	1222	1821	2308	2770	3486	120
	50	135	173	590	751	1452	1836	2519	3163	3619	4511	136
	55	239	306	917	1161	2019	2536	3249	4049	4469	5525	151
	60	392	500	1323	1667	2634	[illegible]	3986	4934	5300	6506	165
	65	604	768	1795	2253	3272	[illegible]	4709	5794	6099	7439	177
	70	879	1116	2317	2899	3911	4825	[illegible]	6515	6959	8319	189
	75	1218	1545	2870	3578	4537	[illegible]	6570	7390	7577	9144	200
50	50	152	195	639	819	1465	1886	2452	3087	3407	4252	120
	55	272	348	[illegible]	[illegible]	2050	2585	3150	3934	4209	5209	135
	60	446	572	1414	1791	2630	3320	3848	4771	4993	6134	148
	65	682	873	1896	2391	3261	4033	4529	5580	5747	7016	161
	70	953	[illegible]	2415	3034	3865	4792	5184	6351	6467	7850	173
	75	1346	1716	2952	3694	4453	5491	5908	7079	7150	8634	183
	80	1761	2249	3490	4351	5014	6154	6309	7761	7796	9369	193
55	55	299	387	1032	1319	2022	2556	2989	3737	3905	4833	120
	60	491	633	1464	1862	2593	3203	3647	4527	4644	5707	133
	65	747	962	1944	2451	3180	3968	4290	5290	5360	6544	146
	70	1068	1371	2451	3039	3750	4654	4908	6017	6046	7339	158
	75	1445	1851	2966	3721	4301	5311	5499	6705	6699	8091	168
	80	1857	2385	3475	4341	4827	5931	6060	7353	7321	8799	179
60	60	526	692	1478	1884	2499	3141	3413	4236	4282	5262	120
	65	793	1031	1947	2471	3048	3808	4019	4957	4962	6058	132
	70	1131	1458	2436	3075	3587	4455	4605	5646	5617	6819	144
	75	1515	1947	2923	3576	4106	5072	5167	6301	6246	7542	155
	80	1935	2479	3405	4259	4602	5657	5703	6921	6845	8227	165
65	65	833	1079	1913	2431	2886	3607	3736	4607	4570	5577	120
	70	1172	1514	2379	3007	3394	4216	4293	5262	5197	6306	131
	75	1556	2003	2844	3576	3885	4800	4830	5888	5802	7004	142
	80	1967	2525	3296	4125	4356	5354	5344	6484	6382	7668	152
70	70	1191	1542	2294	2900	3187	3958	3983	4880	4793	5814	120
	75	1569	2022	2733	3437	3653	4511	4496	5480	5375	6486	131
	80	1988	2529	3159	3954	4101	5039	4991	6053	5937	7131	141
75	75	1559	2012	2603	3273	3417	4218	4173	5083	4971	5995	120
	80	1942	2497	3006	3761	3845	4722	4650	5636	5514	6620	130
80	80	1896	2437	2843	3555	3593	4410	4324	5238	5115	6138	120

TABLE 40.--CURRENT AND PROJECTED MERCHANTABLE CUBIC FOOT VOLUME(VIOI,VIOO) AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX 50		60		70		80		90		PROJECTED BASAL AREA
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
		130 SQ. FT. INITIAL BASAL AREA										
20	20	0	0	1	1	5	6	18	24	53	70	130
	25	0	0	3	4	18	22	60	77	158	202	165
	30	1	1	10	13	47	58	144	181	349	438	193
	35	3	4	25	31	101	124	288	355	651	802	217
	40	8	10	52	64	192	234	510	621	1084	1319	236
	45	18	21	99	120	334	404	829	1000	1661	2003	252
	50	34	42	173	208	542	650	1261	1510	2386	2857	266
25	25	0	1	5	6	24	31	82	107	212	275	130
	30	2	2	15	19	66	84	202	256	477	606	159
	35	5	[illegible]	36	45	144	180	403	504	822	1103	183
	40	12	15	75	94	273	337	704	869	1438	1775	203
	45	25	31	141	173	468	572	1119	1368	2140	2617	221
	50	49	60	243	297	742	902	1654	2007	2974	3609	236
	55	87	107	393	478	1109	1341	2305	2782	3912	4719	249
30	30	2	3	19	25	85	109	254	326	530	746	130
	35	7	8	48	61	189	233	512	648	1077	1362	154
	40	16	20	101	127	378	467	890	1112	1732	2163	175
	45	34	43	189	235	608	753	1391	1721	2524	3119	193
	50	66	82	322	398	949	1167	2009	2467	3419	4192	209
	55	116	145	515	632	1388	1698	2728	3329	4382	5338	223
	60	194	241	776	950	1922	2341	3523	4279	5378	6515	236
35	35	8	11	59	76	229	292	600	765	1206	1538	130
	40	21	26	127	161	437	552	1042	1313	1926	2425	151
	45	44	56	238	299	739	925	1609	2009	2765	3445	169
	50	85	107	405	505	1141	1417	2283	2828	3680	4545	186
	55	150	188	640	794	1639	2024	3036	3737	4631	5679	201
	60	247	310	951	1175	2222	2731	3838	4699	5588	6810	214
	65	368	484	1341	1653	2872	3517	4652	5681	6525	7909	225
40	40	25	32	151	192	503	640	1143	1452	2010	2545	130
	45	54	69	265	330	849	1071	1752	2204	2860	3582	148
	50	104	133	484	609	1298	1625	2453	3060	3763	4671	165
	55	184	233	759	950	1837	2287	3212	3979	4632	5767	180
	60	303	383	1114	1388	2447	3031	3999	4923	5590	6839	193
	65	472	594	1546	1921	3106	3830	4788	5863	6468	7868	206
	70	699	877	2046	2535	3788	4653	5559	6775	7306	8840	217
45	45	64	82	325	415	928	1179	1817	2296	2832	3559	130
	50	124	158	565	703	1409	1776	2521	3159	3705	4612	146
	55	219	279	864	1089	1971	2463	3266	4063	4582	5659	161
	60	360	457	1253	1574	2509	[illegible]	4024	4973	5441	6673	175
	65	555	704	1714	2145	3238	4013	4772	5853	6357	7639	188
	70	813	1029	2232	2784	3895	4806	5495	6716	7054	8550	199
	75	1135	1435	2789	3468	4544	5533	6186	7524	7796	9403	209
50	50	141	182	611	779	1470	1862	2502	3146	3548	4425	130
	55	252	323	947	1202	2038	2564	3222	4019	4380	5418	145
	60	413	528	1361	1719	2659	3313	3944	4886	5193	6377	159
	65	634	809	1839	2312	3270	4077	4651	5726	5975	7290	171
	70	919	1170	2391	2959	3905	4832	5332	6550	5719	8152	183
	75	1266	1612	2909	3632	4516	5562	5930	7234	7423	8901	193
	80	1675	2125	3464	4310	5101	[illegible]	6393	7993	8087	9717	203
55	55	281	362	[illegible]	1282	2047	2583	3106	3880	4119	5098	130
	60	461	592	[illegible]	1818	2640	3311	3791	4703	4888	6006	144
	65	703	902	1916	2420	3243	4043	4460	5497	5630	6874	156
	70	1011	1294	2432	3059	3837	4758	5104	6254	6339	7695	168
	75	1379	1761	2933	3711	4412	5444	5718	6959	7013	8469	179
	80	1797	[illegible]	[illegible]	[illegible]	4962	6093	6297	7639	7650	9195	189
60	60	501	646	1471	1872	2578	3238	3592	4459	4556	5599	130
	65	791	981	1949	2483	3151	3934	4226	5211	5262	6425	142
	70	1096	1395	2452	3091	3714	4610	4836	5929	5941	7212	154
	75	1465	1878	2961	3716	4257	5287	5419	6608	6588	7956	165
	80	1887	2412	3462	4327	4775	5908	5973	7249	7204	8659	175
65	65	806	1041	1943	2467	3021	3774	3968	4894	4890	5969	130
	70	1140	1470	2428	3066	3553	4413	4549	5577	5540	6724	142
	75	1525	1960	2913	3661	4067	5025	5106	6227	6164	7443	152
	80	1943	2491	3388	4238	4559	5603	5638	6842	6760	8124	163
70	70	1175	1519	2371	2996	3370	4186	4256	5216	5148	6247	130
	75	1558	2008	2832	3551	3858	4766	4790	5839	5750	6941	141
	80	1969	2527	3281	4105	4326	5317	5302	6432	6328	7603	151
75	75	1569	2024	2726	3429	3639	4495	4478	5457	5352	6458	130
	80	1967	2528	3151	3944	4086	5021	4971	6029	5913	7102	140
80	80	1942	2497	3007	3762	3846	4724	4652	5639	5517	6623	130

TABLE 41.--CURRENT AND PROJECTED MERCHANTABLE CUBIC FOOT VOLUME(V10I,V10O) AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX 50		60		70		80		90		PROJECTED BASAL AREA
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
						140 SQ. FT. INITIAL BASAL AREA						
20	20	0	0	1	1	4	6	17	22	49	65	140
	25	0	0	[illegible]	4	16	20	55	70	144	183	175
	30	1	1	9	12	42	52	130	162	317	395	203
	35	3	4	22	28	91	112	260	319	593	727	226
	40	7	9	47	57	174	211	464	562	994	1205	245
	45	16	19	89	108	304	366	759	912	1536	1845	261
	50	31	38	157	189	496	593	1164	1399	2228	2657	274
25	25	0	0	4	5	22	29	76	98	196	254	140
	30	2	2	13	17	60	76	184	233	438	555	169
	35	4	6	33	41	131	162	367	457	812	1012	193
	40	11	13	68	84	247	304	643	791	1331	1637	213
	45	23	28	127	156	425	518	1029	1253	1998	2433	230
	50	44	54	220	268	678	821	1533	1853	2803	3388	245
	55	78	95	359	433	1021	1230	2157	2593	3723	4475	258
30	30	2	3	18	22	78	100	236	301	546	699	140
	35	6	8	44	55	172	217	473	596	1011	1274	164
	40	15	18	91	114	326	405	823	1024	1633	2031	185
	45	31	39	170	211	556	685	1294	1594	2396	2950	203
	50	59	74	292	359	873	1069	1834	2304	3273	3999	219
	55	105	130	468	573	1286	1566	2582	3139	4233	5139	233
	60	175	217	711	867	1796	2179	3336	4073	5238	6326	245
35	35	8	10	55	69	212	270	565	719	1159	1473	140
	40	19	24	116	146	404	508	991	1232	1956	2328	161
	45	40	50	217	271	664	822	1522	1834	2679	3327	179
	50	76	96	369	459	1061	1312	2176	2686	3589	4420	196
	55	135	169	585	724	1535	1808	2918	3579	4549	5564	210
	60	224	279	875	1078	2099	2571	3721	4541	5525	6718	223
	65	352	438	1244	1528	2739	3342	4555	5575	6488	7843	235
40	40	23	29	133	177	472	599	1099	1392	1982	2503	140
	45	49	63	262	330	798	1003	1691	2120	2830	3536	159
	50	95	120	446	558	1225	1520	2352	2932	3742	4634	175
	55	167	210	701	874	1746	2165	3141	3879	4579	5662	190
	60	275	346	1035	1285	2345	2895	3938	4836	5611	6854	203
	65	430	539	1448	1792	3002	3690	4745	5798	6518	7916	215
	70	639	800	1933	2397	3693	4523	5541	6740	7386	8925	226
45	45	58	75	304	386	888	1124	1790	2257	2861	3589	140
	50	113	144	517	652	1353	1699	2495	3119	3752	4664	157
	55	200	253	808	1014	1934	2377	3250	4034	4654	5740	172
	60	328	416	1179	1474	2520	3130	4025	4935	5540	6786	185
	65	509	643	1625	2026	3176	3926	4795	5883	6394	7786	197
	70	749	945	2135	2653	3849	4738	5546	6768	7208	8729	209
	75	1055	1328	2691	3336	4518	5541	6263	7609	7976	9613	219
50	50	131	167	578	734	1438	1816	2523	3166	3655	4554	140
	55	232	295	928	1135	2024	2514	3260	4060	4515	5580	155
	60	380	484	1298	1635	2620	3239	4004	4954	5356	6573	169
	65	586	744	1767	2215	3263	4050	4737	5825	6165	7518	181
	70	855	1084	2288	2859	3909	4830	5443	6658	6934	8409	193
	75	1188	1505	2842	3541	4544	5589	6117	7445	7661	9244	203
	80	1583	2002	3411	4235	5154	6313	6753	8182	8345	10023	213
55	55	261	336	969	1231	2047	2578	3192	3983	4303	5323	140
	60	429	549	1388	1755	2653	3321	3902	4837	5101	6266	154
	65	657	840	1808	2353	3274	4075	4597	5662	5870	7164	166
	70	950	1212	2390	2998	3951	4918	5256	6449	6602	8012	178
	75	1306	1662	2933	3666	4490	5534	5902	7191	7296	8809	189
	80	1717	2181	3480	4334	5063	6213	6503	7887	7951	9555	199
60	60	471	607	1446	1836	2629	3298	3744	4645	4805	5905	140
	65	719	924	1928	2437	3224	4021	4404	5429	5538	6762	153
	70	1032	1322	2442	3073	3810	4726	5038	6175	6239	7574	164
	75	1404	1794	2967	3719	4377	5402	5643	6880	6906	8340	175
	80	1823	2325	3490	4356	4918	6041	6217	7543	7537	9060	185
65	65	771	994	1951	2472	3129	3907	4178	5152	5191	6338	140
	70	1098	1411	2450	3090	3686	4576	4782	5863	5864	7118	152
	75	1479	1897	2955	3710	4223	5215	5360	6536	6506	7858	162
	80	1900	2431	3451	4314	4735	5820	5910	7171	7118	8556	173
70	70	1146	1478	2422	3059	3531	4385	4511	5530	5488	6662	140
	75	1531	1968	2905	3651	4041	4992	5065	6176	6109	7377	151
	80	1948	2498	3376	4223	4529	5567	5594	6788	6703	8056	161
75	75	1560	2010	2825	3553	3844	4748	4768	5813	5722	6908	140
	80	1959	2528	3273	4096	4310	5297	5279	6405	6299	7569	150
80	80	1967	2528	3150	3943	4085	5019	4970	6027	5910	7099	140

TABLE 42.--CURRENT AND PROJECTED MERCHANTABLE CUBIC FOOT VOLUME(V101,V100) AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX										PROJECTED BASAL AREA
		50		60		70		80		90		
YEARS		I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	I.B.	O.B.	SQ. FT.
		150 SQ. FT. INITIAL BASAL AREA										
20	20	0	0	1	1	4	5	16	20	45	59	150
	25	0	0	3	3	14	18	49	63	130	165	185
	30	1	1	8	10	38	47	117	146	287	356	213
	35	3	3	20	25	82	100	235	288	539	659	235
	40	7	8	42	52	157	190	422	509	911	1100	253
	45	14	17	81	98	277	332	696	832	1420	1699	269
	50	28	34	143	172	454	541	1075	1277	2078	2470	281
25	25	0	0	4	5	20	26	69	89	181	233	150
	30	1	2	12	15	54	68	167	211	401	506	179
	35	4	5	29	36	118	146	333	413	745	924	202
	40	10	12	61	75	223	274	587	718	1229	1505	222
	45	20	25	115	140	386	469	945	1146	1860	2255	239
	50	40	49	199	242	620	748	1419	1709	2633	3171	253
	55	71	87	326	393	940	1128	2014	2413	3532	4230	266
30	30	2	2	15	20	72	91	217	277	509	649	150
	35	5	7	39	50	157	197	435	546	942	1182	174
	40	13	16	82	103	297	368	758	939	1528	1893	195
	45	28	35	154	190	507	622	1199	1471	2260	2772	213
	50	53	66	265	324	800	976	1759	2142	3116	3793	228
	55	95	117	426	520	1188	1441	2433	2946	4065	4919	242
	60	159	196	651	791	1674	2023	3202	3661	5075	6111	253
35	35	7	9	50	63	195	248	528	669	1103	1396	150
	40	17	21	105	132	371	465	917	1147	1771	2214	171
	45	36	45	196	245	630	781	1430	1772	2572	3184	189
	50	69	86	336	415	981	1209	2059	2532	3473	4264	205
	55	122	151	534	658	1431	1753	2785	3405	4437	5411	220
	60	202	251	804	986	1974	2408	3584	4359	5427	6582	232
	65	320	395	1152	1408	2600	3161	4425	5361	6415	7743	243
40	40	21	27	128	162	440	556	1047	1320	1932	2433	150
	45	45	56	240	301	744	931	1616	2019	2772	3454	169
	50	85	108	408	509	1140	1426	2291	2840	3036	4554	185
	55	151	189	645	800	1648	2035	3045	3750	4637	5687	200
	60	249	312	957	1184	2232	2745	3648	4712	5591	6815	213
	65	391	488	1350	1664	2633	3532	4670	5692	6526	7912	225
	70	585	729	1818	2237	3577	4369	5489	6652	7424	8958	235
45	45	53	68	281	356	841	1061	1743	2192	2857	3577	150
	50	103	130	478	601	1297	1611	2443	3046	3762	4666	167
	55	181	229	750	938	1823	2268	3203	3965	4684	5768	182
	60	239	377	1101	1372	2432	3011	3992	4912	5596	6845	195
	65	465	585	1530	1900	3091	3809	4783	5855	6479	7879	207
	70	689	865	2028	2512	3775	4635	5558	6772	7321	8857	218
	75	976	1224	2531	3199	4463	5461	6303	7647	8117	9773	228
50	50	120	153	541	605	1391	1751	2515	3149	3726	4636	150
	55	212	270	845	1063	1949	2439	3264	4059	4612	5693	165
	60	348	442	1228	1539	2557	3194	4029	4975	5480	6718	179
	65	539	682	1684	2104	3219	3386	4785	5875	6317	7696	191
	70	791	999	2199	2740	3892	4787	5517	6740	7112	8519	202
	75	1107	1397	2757	3424	4539	5573	6217	7559	7863	9482	213
	80	1458	1875	3336	4132	5174	6329	6878	6326	6568	10286	222
55	55	241	309	923	1169	2023	2542	3245	4045	4453	5506	150
	60	396	506	1330	1677	2638	3295	3979	4926	5231	6482	164
	65	609	776	1604	2265	3274	4009	4692	5702	6076	7412	176
	70	887	1126	2326	2911	3911	4836	5203	6600	6833	8288	188
	75	1228	1559	2878	3589	4534	5531	6054	7371	7548	9110	198
	80	1629	2063	3440	4277	5132	6290	6678	8094	8222	9877	208
60	60	440	565	1406	1780	2652	3322	3866	4793	5027	6176	150
	65	674	863	1887	2380	3266	4068	4551	5607	5786	7063	163
	70	973	1242	2403	3024	3975	4201	5211	6383	6510	7902	174
	75	1333	1699	2947	3686	4466	5506	5838	7115	7197	8690	185
	80	1747	2222	3487	4347	5030	6174	6432	7801	7845	9428	195
65	65	730	939	1936	2448	3208	4003	4361	5377	5470	6679	150
	70	1046	1341	2447	3001	3729	4701	4989	6116	6165	7485	162
	75	1420	1817	2568	3722	4349	5369	5589	6814	6827	8245	173
	80	1841	2349	3485	4352	4884	6000	6157	7471	7455	8960	183
70	70	1105	1422	2448	3089	3666	4552	4746	5818	5812	7056	150
	75	1487	1908	2950	3705	4139	5186	5320	6488	6452	7792	161
	80	1909	2442	3443	4304	4709	5787	5867	7120	7061	8487	171
75	75	1533	1972	2900	3645	4027	4975	5043	6150	6080	7342	150
	80	1951	2501	3369	4215	4513	5549	5571	6760	6673	8019	160
80	80	1970	2529	3271	4034	4307	5294	5275	6400	6294	7563	150

Current and Projected Cord (C5) and Board Foot Int. 1/4 (BF) Volume and Total Basal Area Per Acre

TABLE 43.--CURRENT AND PROJECTED CORD(C5) AND BOARD FOOT INT. 1/4(BF) VOLUME AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX 50		60		70		80		90		PROJECTED BASAL AREA
YEARS		CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	SQ. FT.
20 SQ. FT. INITIAL BASAL AREA												
20	20	1.7	0	2.3	0	2.9	20	3.6	80	4.3	230	20
	25	4.5	0	5.8	30	7.1	150	8.6	520	10.2	1260	37
	30	8.4	10	10.5	130	12.7	620	15.2	1770	18.0	3640	56
	35	12.9	50	16.0	420	19.2	1650	22.8	4070	27.0	7410	74
	40	17.8	150	21.8	1020	26.1	3430	31.0	7390	36.5	12210	93
	45	22.8	360	27.7	2050	33.1	5950	39.2	11500	46.2	17630	110
	50	27.8	730	33.6	3590	40.1	9160	47.4	16110	55.8	23350	126
25	25	2.6	0	3.2	20	3.9	110	4.7	360	5.5	830	20
	30	5.2	10	6.4	110	7.7	510	9.2	1370	10.9	2660	33
	35	8.6	50	10.5	410	12.5	1490	14.9	3370	17.5	5710	48
	40	12.5	170	15.1	1050	18.0	3220	21.3	6310	25.0	9670	63
	45	16.7	410	20.1	2190	23.8	5690	28.1	9920	33.1	14200	78
	50	21.0	880	25.2	3870	29.8	8720	35.1	13930	41.3	19030	93
	55	25.4	1630	30.3	6070	35.8	12120	42.1	18140	49.5	23980	106
30	30	3.2	10	3.9	90	4.7	370	5.5	950	6.5	1780	20
	35	5.7	50	6.8	340	8.2	1170	9.6	2510	11.3	4040	31
	40	8.7	160	10.4	940	12.4	2660	14.6	4860	17.1	7120	43
	45	12.1	410	14.4	2020	17.1	4800	20.1	7820	23.6	10750	56
	50	15.7	910	18.7	3640	22.1	7430	26.0	11150	30.5	14720	68
	55	19.5	1720	23.1	5710	27.3	10360	32.0	14690	37.6	18890	81
	60	23.3	2910	27.6	8120	32.5	13450	38.1	18320	44.7	23130	93
35	35	3.7	40	4.4	260	5.3	860	6.2	1760	7.3	2750	20
	40	6.0	130	7.1	760	8.5	2040	10.0	3560	11.7	5060	29
	45	8.7	330	10.3	1710	12.2	3790	14.3	5890	16.8	7910	40
	50	11.7	860	13.8	3130	16.3	5960	19.2	8590	22.5	11130	50
	55	14.9	1650	17.6	4330	20.7	8410	24.3	11530	28.5	14600	61
	60	18.2	2810	21.5	7060	25.3	11020	29.6	14610	34.7	18220	72
	65	21.6	4290	25.4	9310	29.9	13710	35.0	17760	41.0	21920	82
40	40	4.1	110	4.9	590	5.8	1500	6.8	2540	8.0	3540	20
	45	6.2	320	7.4	1370	8.7	2870	10.2	4340	12.0	5740	28
	50	8.6	750	10.2	2560	12.0	4620	14.1	6500	16.6	8320	37
	55	11.3	1490	13.4	4100	15.7	6640	18.4	8920	21.6	11180	46
	60	14.2	2540	16.7	5900	19.6	8820	23.0	11510	26.9	14240	56
	65	17.1	3680	20.2	7800	23.7	11120	27.7	14210	32.4	17430	65
	70	20.2	5430	23.7	9800	27.8	13460	32.5	16930	38.1	20710	74
45	45	4.4	260	5.3	1050	6.2	2130	7.3	3160	8.5	4130	20
	50	6.4	630	7.5	2020	8.9	3520	10.4	4870	12.2	6180	27
	55	8.6	1270	10.1	3230	11.9	5160	14.0	6840	16.4	8520	35
	60	11.0	2200	13.0	4780	15.2	6900	17.8	9000	20.9	11090	43
	65	13.6	3370	16.0	6400	18.7	8920	21.9	11310	25.7	13820	51
	70	16.2	4720	19.1	8110	22.4	10950	26.2	13720	30.6	16580	60
	75	19.0	6170	22.3	9970	26.1	13030	30.5	16190	35.7	19610	68
50	50	4.7	510	5.6	1550	6.5	2650	7.7	3630	9.0	4580	20
	55	6.5	1050	7.7	2600	9.0	3900	10.6	5220	12.4	6480	26
	60	8.5	1840	10.1	3920	11.8	5480	13.8	7020	16.2	8620	33
	65	10.7	2850	12.6	5190	14.8	7120	17.3	8990	20.3	10960	41
	70	13.1	4010	15.4	6350	18.0	8870	21.1	11060	24.6	13420	48
	75	15.5	5250	18.2	8170	21.3	10680	24.9	13230	29.1	16000	56
	80	18.0	6550	21.1	9720	24.7	12550	28.8	15460	33.7	18650	63
55	55	4.9	850	5.8	2020	6.8	3050	8.0	3980	9.4	4920	20
	60	6.6	1510	7.8	3030	9.2	4290	10.7	5460	12.6	6690	26
	65	8.5	2360	10.0	4170	11.7	5670	13.7	7110	16.0	8660	32
	70	10.5	3350	12.3	5410	14.5	7160	16.9	8900	19.8	10790	39
	75	12.7	4420	14.8	6720	17.4	8740	20.3	10800	23.7	13050	45
	80	14.9	5540	17.4	8090	20.4	10390	23.8	12770	27.8	15400	52
60	60	5.1	1220	6.1	2330	7.1	3340	8.3	4240	9.7	5190	20
	65	6.7	1930	7.9	3340	9.3	4500	10.8	5630	12.7	6850	25
	70	8.5	2770	9.9	4390	11.6	5770	13.6	7160	15.9	8670	31
	75	10.3	3680	12.1	5520	14.2	7140	16.6	8810	19.4	10640	37
	80	12.3	4660	14.4	6710	16.8	8390	19.7	10550	23.0	12710	43
65	65	5.3	1570	6.2	2660	7.3	3570	8.6	4450	10.0	5410	20
	70	6.8	2270	8.0	3550	9.4	4650	10.9	5760	12.8	6970	25
	75	8.4	3050	9.9	4520	11.6	5830	13.5	7180	15.8	8670	30
	80	10.2	3890	11.9	5560	13.9	7100	16.3	8710	19.0	10490	36
70	70	5.5	1850	6.4	2870	7.5	3740	8.8	4630	10.3	5600	20
	75	6.9	2520	8.1	3700	9.4	4760	11.0	5860	12.9	7070	25
	80	8.4	3240	9.9	4600	11.5	5370	13.4	7190	15.7	8660	29
75	75	5.6	2070	6.6	3020	7.7	3880	9.0	4780	10.5	5760	20
	80	6.9	2700	8.1	3810	9.5	4840	11.1	5940	13.0	7150	24
80	80	5.7	2240	6.7	3150	7.8	4000	9.2	4900	10.7	5900	20

TABLE 44.--CURRENT AND PROJECTED CORD(CS) AND BOARD FOOT INT. 1/4(BF) VOLUME AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX										PROJECTED BASAL AREA
		50		60		70		80		90		
YEARS		CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	SQ. FT.
30 SQ. FT. INITIAL BASAL AREA												
20	20	2.4	0	3.4	0	4.4	20	5.3	100	6.4	300	30
	25	6.0	0	7.9	30	9.8	170	11.8	590	14.0	1470	51
	30	10.6	10	13.5	130	16.5	630	19.8	1870	23.5	4020	73
	35	15.7	50	19.9	400	24.0	1610	28.6	4160	33.9	7980	94
	40	21.1	130	26.3	930	31.7	3260	37.7	7480	44.5	13040	113
	45	26.5	310	32.7	1830	39.3	5650	46.7	11640	55.1	18810	131
	50	31.8	620	39.0	3180	46.7	8730	55.4	16410	65.3	24950	148
25	25	3.8	0	4.8	30	5.8	140	7.0	470	8.3	1110	30
	30	7.2	10	8.9	130	10.8	590	12.8	1650	15.2	3330	47
	35	11.3	50	13.9	430	16.7	1630	19.8	3890	23.3	6880	64
	40	15.9	160	19.3	1060	23.1	3420	27.3	7120	32.2	11420	81
	45	20.6	380	24.9	2140	29.7	5980	35.1	11100	41.3	16560	98
	50	25.3	790	30.5	3750	36.3	9160	42.8	15530	50.4	21990	113
	55	30.1	1460	36.1	5910	42.8	12800	50.5	20180	59.3	27490	128
30	30	4.7	10	5.8	110	7.0	480	8.3	1280	9.8	2460	30
	35	7.9	50	9.6	400	11.5	1430	13.6	3200	16.0	5340	44
	40	11.6	170	14.0	1040	16.7	3120	19.7	6020	23.2	9110	58
	45	15.7	420	18.8	2170	22.3	5530	26.3	9490	30.9	13450	73
	50	19.8	890	23.7	3860	28.0	8500	33.0	13370	38.8	18100	87
	55	24.1	1650	28.6	6050	33.9	11810	39.8	17430	46.8	22890	100
	60	28.3	2790	33.6	8640	39.6	15300	46.6	21550	54.6	27680	113
35	35	5.5	50	6.6	330	7.9	1150	9.3	2450	11.0	3930	30
	40	8.5	160	10.1	930	12.0	2610	14.2	4760	16.7	6950	42
	45	11.8	410	14.1	2000	16.6	4720	19.6	7660	23.0	10510	54
	50	15.4	910	18.3	3610	21.6	7320	25.4	10950	29.8	14430	67
	55	19.1	1720	22.7	5660	26.7	10220	31.4	14440	36.8	18540	79
	60	22.9	2910	27.1	8050	31.9	13270	37.4	18030	43.9	22740	91
	65	26.7	4450	31.5	10630	37.0	16380	43.5	21640	50.9	26950	102
40	40	6.1	140	7.3	770	8.6	2080	10.2	3630	12.0	5170	30
	45	8.8	380	10.5	1730	12.4	3840	14.6	6000	17.2	8060	40
	50	11.9	860	14.1	3170	16.6	6040	19.5	8730	22.9	11320	51
	55	15.1	1660	17.9	5010	21.0	8520	24.7	11700	29.0	14820	62
	60	18.5	2820	21.8	7120	25.6	11160	30.1	14810	35.2	18480	73
	65	21.9	4300	25.8	9400	30.3	13870	35.5	17930	41.6	22210	83
	70	25.3	6040	29.8	11750	34.9	16610	40.9	21180	47.9	25960	94
45	45	6.6	330	7.9	1430	9.3	3040	10.9	4610	12.8	6110	30
	50	9.2	770	10.8	2670	12.8	4860	15.0	6870	17.6	8800	39
	55	11.9	1520	14.1	4260	16.6	6960	19.4	9370	22.8	11770	49
	60	14.9	2600	17.5	6100	20.6	9220	24.1	12050	28.3	14930	58
	65	17.9	3970	21.1	8090	24.7	11380	29.0	14840	33.9	18220	68
	70	21.0	5550	24.7	10150	29.0	13990	33.9	17680	39.7	21570	78
	75	24.1	7270	28.3	12230	33.2	16430	38.8	20540	45.4	24960	87
50	50	7.0	670	8.3	2190	9.8	3850	11.5	5350	13.5	6810	30
	55	9.4	1340	11.1	3540	13.0	5610	15.3	7460	17.9	9300	38
	60	11.9	2310	14.1	5120	16.5	7540	19.4	9750	22.7	12030	47
	65	14.6	3540	17.2	6840	20.2	9590	23.7	12180	27.7	14900	55
	70	17.4	4950	20.5	8640	24.0	11710	28.1	14700	32.8	17890	64
	75	20.3	6470	23.8	10470	27.8	13890	32.6	17280	38.1	20940	73
	80	23.1	8040	27.1	12330	31.7	16070	37.1	19880	43.3	24020	81
55	55	7.4	1150	8.7	2900	10.2	4480	12.0	5910	14.1	7340	30
	60	9.6	2000	11.3	4240	13.3	6120	15.5	7870	18.2	9670	37
	65	12.0	3090	14.1	5720	16.5	7900	19.3	9980	22.6	12180	45
	70	14.4	4330	16.9	7280	19.9	9770	23.3	12200	27.2	14820	53
	75	17.0	5660	19.9	8910	23.3	11700	27.3	14510	31.9	17560	61
	80	19.6	7050	23.0	10560	26.9	13670	31.4	16860	36.7	20350	69
60	60	7.7	1700	9.1	3480	10.6	4960	12.5	6330	14.6	7760	30
	65	9.8	2640	11.5	4750	13.4	6490	15.7	8160	18.4	9940	37
	70	12.0	3730	14.0	6110	16.4	8120	19.2	10110	22.5	12270	44
	75	14.3	4900	16.7	7540	19.6	9840	22.9	12170	26.8	14710	51
	80	16.6	6120	19.5	9020	22.8	11610	26.6	14290	31.1	17240	58
65	65	8.0	2240	9.4	3920	11.0	5310	12.8	6670	15.0	8110	30
	70	9.9	3180	11.6	5110	13.6	6740	15.9	8380	18.6	10150	36
	75	12.0	4200	14.0	6360	16.4	8260	19.2	10200	22.4	12320	43
	80	14.1	5280	16.5	7680	19.3	9850	22.6	12110	26.4	14590	49
70	70	8.2	2690	9.6	4250	11.3	5590	13.2	6940	15.4	8400	30
	75	10.0	3580	11.7	5360	13.8	6930	16.1	8550	18.8	10320	36
	80	12.0	4540	14.0	6530	16.4	8350	19.1	10250	22.4	12360	42
75	75	8.4	3040	9.8	4510	11.5	5820	13.5	7160	15.7	8640	30
	80	10.1	3880	11.9	5550	13.9	7080	16.2	8680	18.9	10460	35
80	80	8.6	3310	10.1	4710	11.8	6000	13.7	7350	16.0	8860	30

TABLE 45.--CURRENT AND PROJECTED CORD(CS) AND BOARD FOOT INT. 1/4(BF) VOLUME AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX										PROJECTED BASAL AREA
		50		60		70		80		90		
YEARS		CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	SQ. FT.
40 SQ. FT. INITIAL BASAL AREA												
20	20	3.0	0	4.5	0	5.7	30	7.1	120	8.5	350	40
	25	7.2	0	9.7	30	12.1	180	14.7	620	17.6	1560	64
	30	12.3	10	16.1	130	19.8	610	23.8	1850	28.3	4110	88
	35	17.8	40	22.9	370	28.0	1510	33.5	4030	39.7	8050	110
	40	23.4	120	29.8	830	36.2	3010	43.3	7200	51.2	13130	131
	45	29.0	270	36.6	1610	44.3	5200	52.8	11260	62.4	19020	149
	50	34.5	530	43.1	2900	52.0	8080	61.8	16010	73.0	25360	166
25	25	4.9	0	6.3	30	7.7	160	9.3	540	11.0	1310	40
	30	8.9	10	11.2	140	13.6	630	16.2	1800	19.2	3750	59
	35	13.6	50	16.9	420	20.3	1650	24.2	4120	28.6	7590	79
	40	18.6	150	22.8	1010	27.4	3410	32.5	7460	38.4	12470	97
	45	23.7	350	28.9	2010	34.6	5920	41.0	11600	48.3	17990	115
	50	28.8	710	34.9	3500	41.7	9100	49.3	16260	58.0	23830	131
	55	33.7	1290	40.7	5530	48.5	12810	57.3	21200	67.4	29740	146
30	30	6.2	10	7.7	120	9.3	550	11.0	1530	13.0	3020	40
	35	10.0	50	12.2	420	14.6	1570	17.3	3670	20.4	6350	56
	40	14.3	160	17.3	1060	20.6	3360	24.4	6780	28.7	10630	72
	45	18.7	400	22.6	2180	26.8	5890	31.7	10600	37.3	15490	88
	50	23.3	640	28.0	3840	33.2	9020	39.1	14850	46.0	20650	103
	55	27.8	1550	33.3	6030	39.4	12570	46.5	19300	54.6	25890	117
	60	32.3	2590	38.5	8670	45.6	16330	53.6	23790	62.9	31100	131
35	35	7.3	50	8.8	380	10.5	1360	12.4	3010	14.6	4980	40
	40	10.8	160	13.0	1020	15.4	3010	18.2	5710	21.4	8560	54
	45	14.6	420	17.5	2150	20.8	5360	24.5	9050	28.7	12710	68
	50	18.7	900	22.3	3820	26.3	8240	31.0	12780	36.4	17170	81
	55	22.8	1690	27.1	5990	32.0	11450	37.6	16700	44.1	21780	95
	60	26.9	2840	31.9	8540	37.6	14840	44.2	20690	51.8	26430	107
	65	30.9	4370	36.6	11340	43.1	18270	50.6	24650	59.3	31020	119
40	40	8.1	150	9.7	910	11.5	2540	13.6	4600	15.9	6680	40
	45	11.4	410	13.5	1970	16.0	4610	18.9	7430	22.1	10150	52
	50	14.9	910	17.7	3560	20.9	7150	24.5	10630	28.8	13980	64
	55	18.5	1720	21.9	5590	25.9	9990	30.4	14050	35.7	18000	76
	60	22.2	2910	26.3	7940	31.0	12980	36.4	17570	42.6	22130	88
	65	26.0	4440	30.7	10480	36.1	16030	42.3	21120	49.5	26270	100
	70	29.7	6280	35.0	13100	41.1	19080	48.1	24640	56.4	30380	110
45	45	8.8	380	10.4	1720	12.3	3820	14.5	5960	17.0	8000	40
	50	11.8	860	14.0	3160	16.5	6010	19.4	8680	22.7	11240	51
	55	15.0	1660	17.8	4990	20.9	8480	24.6	11640	28.8	14740	62
	60	18.4	2820	21.7	7100	25.5	11100	29.9	14730	35.0	18380	72
	65	21.8	4300	25.6	9370	30.1	13810	35.3	17900	41.4	22100	83
	70	25.2	6030	29.6	11710	34.8	16530	40.7	21080	47.7	25840	93
	75	28.6	7930	33.6	14060	39.4	19240	46.1	24250	53.9	29560	103
50	50	9.3	780	11.1	2710	13.0	4950	15.3	7000	18.0	8980	40
	55	12.2	1540	14.4	4320	16.9	7080	19.8	9550	23.2	11990	50
	60	15.1	2620	17.8	6190	21.0	9370	24.6	12260	28.8	15200	59
	65	18.2	4000	21.4	8190	25.2	11760	29.5	15080	34.5	18520	69
	70	21.3	5600	25.1	10280	29.4	14200	34.4	17950	40.3	21910	79
	75	24.5	7330	28.7	12380	33.7	16650	39.4	20830	46.1	25320	88
	80	27.6	9120	32.4	14480	37.9	19090	44.3	23710	51.8	28720	97
55	55	9.8	1380	11.6	3680	13.6	5850	16.0	7790	18.7	9730	40
	60	12.5	2370	14.7	5300	17.2	7840	20.2	10160	23.7	12530	49
	65	15.2	3630	17.9	7070	21.0	9940	24.6	12650	28.8	15490	58
	70	18.0	5070	21.2	8910	24.9	12120	29.1	15230	34.1	18540	66
	75	20.9	6630	24.6	10800	28.8	14340	33.7	17860	39.4	21660	75
	80	23.8	8230	27.9	12690	32.7	16570	38.3	20510	44.7	24790	84
60	60	10.2	2100	12.1	4490	14.2	6520	16.6	8390	19.4	10320	40
	65	12.7	3220	14.9	6040	17.5	8370	20.5	10590	24.0	12940	48
	70	15.3	4510	17.9	7670	21.0	10310	24.6	12900	28.8	15680	56
	75	17.9	5900	21.0	9360	24.6	12320	28.8	15290	33.7	18510	64
	80	20.6	7340	24.1	11070	28.2	14350	33.0	17710	38.6	21390	72
65	65	10.6	2820	12.5	5120	14.6	7030	17.1	8860	20.0	10800	40
	70	12.9	3970	15.2	6570	17.8	8760	20.8	10920	24.3	13250	47
	75	15.3	5200	18.0	8070	21.0	10560	24.6	13070	28.8	15810	55
	80	17.8	6490	20.8	9620	24.4	12410	28.5	15290	33.3	18440	62
70	70	10.9	3450	12.8	5600	15.0	7420	17.6	9230	20.5	11190	40
	75	13.1	4550	15.3	6950	18.0	9040	21.0	11170	24.6	13500	47
	80	15.4	5700	18.0	8340	21.0	10720	24.6	13190	28.7	15900	54
75	75	11.2	3960	13.1	5970	15.4	7730	18.0	9540	21.0	11530	40
	80	13.3	4990	15.5	7230	18.2	9260	21.2	11370	24.8	13710	46
80	80	11.4	4350	13.4	6250	15.7	7990	18.3	9810	21.4	11820	40

TABLE 46.--CURRENT AND PROJECTED CORD(CS) AND BOARD FOOT INT. 1/4(BF) VOLUME AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX										PROJECTED BASAL AREA
		50		60		70		80		90		
YEARS		CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	SQ. FT.
50 SQ. FT. INITIAL BASAL AREA												
20	20	3.5	0	5.4	0	7.1	30	8.8	130	10.6	380	50
	25	8.0	0	11.3	30	14.3	170	17.4	620	20.9	1580	77
	30	13.4	10	18.2	120	22.7	570	27.4	1770	32.7	4050	102
	35	19.1	40	25.4	330	31.4	1380	37.8	3800	44.9	7850	126
	40	24.9	100	32.6	740	40.1	2730	48.1	6770	57.0	12810	146
	45	30.7	230	39.6	1420	48.4	4720	57.9	10640	68.6	18660	165
	50	36.4	460	46.4	2470	56.3	7390	67.2	15270	79.5	25090	181
25	25	5.9	0	7.7	30	9.6	170	11.5	590	13.7	1450	50
	30	10.5	10	13.3	130	16.2	630	19.5	1860	23.1	4000	72
	35	15.5	50	19.5	400	23.6	1620	28.2	4160	33.4	7960	92
	40	20.9	140	26.0	940	31.3	3280	37.2	7490	44.0	13010	112
	45	26.2	310	32.4	1850	38.9	5680	46.2	11660	54.5	18760	130
	50	31.5	630	38.6	3210	46.3	8780	54.9	16420	64.7	24870	146
	55	36.7	1140	44.7	5100	53.4	12450	63.2	21530	74.4	31100	161
30	30	7.7	10	9.5	130	11.5	600	13.7	1700	16.2	3460	50
	35	11.9	50	14.7	430	17.6	1640	20.9	3970	24.7	7100	68
	40	16.6	160	20.2	1050	24.2	3430	28.7	7240	33.8	11740	86
	45	21.4	380	26.0	2110	31.0	5990	36.7	11280	43.2	17000	102
	50	26.3	770	31.7	3700	37.7	9190	44.6	15780	52.4	22540	118
	55	31.1	1410	37.3	5920	44.3	12850	52.3	20520	61.5	28160	133
	60	35.8	2370	42.8	8130	50.7	16790	59.8	25320	70.2	33720	146
35	35	9.0	50	10.9	410	13.1	1510	15.5	3450	18.2	5870	50
	40	13.0	170	15.7	1060	18.7	3260	22.0	6440	26.0	9920	65
	45	17.2	410	20.7	2190	24.6	5750	29.0	10100	34.1	14540	81
	50	21.6	870	25.9	3870	30.7	8810	36.1	14180	42.5	19460	95
	55	26.0	1610	31.0	6070	36.7	12250	43.2	18450	50.8	24480	109
	60	30.4	2700	36.1	8700	42.7	15890	50.2	22770	58.9	29490	122
	65	34.6	4170	41.1	11620	48.5	19590	57.0	27040	66.8	34410	135
40	40	10.1	160	12.1	990	14.3	2900	16.9	5430	19.9	8070	50
	45	13.7	420	16.4	2110	19.5	5180	22.9	8640	26.9	12040	63
	50	17.6	910	21.0	3770	24.9	7980	29.3	12240	34.3	16350	77
	55	21.6	1710	25.7	5920	30.3	11110	35.7	16040	41.9	20810	90
	60	25.6	2870	30.4	8430	35.8	14400	42.1	19900	49.4	25320	102
	65	29.6	4410	35.0	11160	41.3	17730	48.4	23760	56.8	29800	114
	70	33.5	6280	39.6	14000	46.5	21040	54.6	27560	63.9	34200	126
45	45	10.9	410	13.0	1940	15.4	4480	18.1	7190	21.3	9800	50
	50	14.3	900	17.0	3500	20.1	6970	23.7	10320	27.8	13530	62
	55	17.9	1720	21.3	5500	25.0	9750	29.4	13660	34.5	17470	74
	60	21.6	2900	25.5	7820	30.1	[illegible]	35.3	17120	41.4	21520	86
	65	25.3	4430	29.8	10320	35.1	15690	41.2	20600	48.2	25590	97
	70	28.9	6260	34.1	12900	40.0	18680	46.9	24070	55.0	29650	108
	75	32.5	8290	38.3	15480	44.9	21630	52.6	27480	61.6	33630	118
50	50	11.6	860	13.8	3130	16.3	5940	19.1	8570	22.4	11100	50
	55	14.8	1660	17.5	4950	20.7	8390	24.3	11500	28.4	14560	61
	60	18.1	2810	21.4	7040	25.2	11000	29.6	14580	34.6	18180	72
	65	21.5	4260	25.4	9300	29.8	13680	34.9	17720	40.9	21870	82
	70	24.9	6010	29.3	11620	34.4	16390	40.3	20890	47.2	25590	92
	75	28.3	7900	33.3	13960	39.0	19080	45.7	24030	53.4	29290	102
	80	31.6	9880	37.1	16270	43.5	21740	50.9	27140	59.5	32940	112
55	55	12.2	1540	14.5	4350	17.0	7120	20.0	9620	23.4	12080	50
	60	15.2	2630	18.0	6220	21.1	9430	24.8	12340	29.0	15300	60
	65	18.3	4010	21.6	8240	25.3	11830	29.7	15170	34.7	18640	70
	70	21.4	5620	25.2	10330	29.6	14280	34.6	18050	40.5	22040	79
	75	24.6	7350	28.9	12440	33.8	16740	39.6	20950	46.3	25460	89
	80	27.7	9150	32.5	14540	38.1	19190	44.6	23830	52.1	28870	98
60	60	12.8	2410	15.0	5410	17.7	8020	20.7	10410	24.3	12850	50
	65	15.6	3680	18.3	7210	21.5	10170	25.2	12940	29.5	15850	59
	70	18.4	5140	21.7	9080	25.4	12380	29.8	15560	34.8	18950	68
	75	21.4	6720	25.1	10990	29.4	14620	34.4	18220	40.2	22100	77
	80	24.3	8350	28.5	12910	33.3	16880	39.0	20900	45.6	25270	86
65	65	13.2	3310	15.5	6260	18.2	8700	21.4	11020	25.0	13470	50
	70	15.9	4640	18.6	7940	21.8	10700	25.5	13390	29.9	16280	58
	75	18.5	6060	21.8	9660	25.5	12750	29.8	15830	34.9	19170	67
	80	21.3	7540	24.9	11410	29.2	14820	34.1	18300	39.9	22110	75
70	70	13.6	4140	16.0	6900	18.7	9230	21.9	11510	25.6	13980	50
	75	16.1	5420	18.9	8460	22.1	11090	25.9	13740	30.2	16620	58
	80	18.6	6760	21.8	10060	25.5	13000	29.9	16020	34.9	19330	65
75	75	14.0	4810	16.4	7390	19.2	9640	22.4	11920	26.2	14410	50
	80	16.3	6020	19.1	8850	22.4	11390	26.1	14010	30.5	16900	57
80	80	14.3	5340	16.7	7770	19.6	9970	22.9	12260	26.7	14780	50

TABLE 47.--CURRENT AND PROJECTED CORD(CS) AND BOARD FOOT INT. 1/4(BF) VOLUME AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX 50		60		70		80		90		PROJECTED BASAL AREA
YEARS		CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	SQ. FT.
60 SQ. FT. INITIAL BASAL AREA												
20	20	3.7	0	6.3	0	8.4	30	10.4	130	12.6	390	60
	25	8.5	0	12.7	30	16.3	170	20.0	600	24.0	1560	89
	30	14.0	10	20.0	110	25.3	530	30.7	1670	36.7	3890	116
	35	19.8	40	27.5	300	34.4	1260	41.7	3520	49.6	7480	139
	40	25.7	90	35.0	650	43.4	2460	52.3	6270	62.2	12250	160
	45	31.5	200	42.1	1260	52.0	4260	62.4	9320	74.1	17970	179
	50	37.5	400	49.0	2190	60.0	6720	71.9	14370	85.2	24380	195
25	25	6.8	0	9.1	30	11.4	180	13.8	610	16.4	1540	60
	30	11.8	10	15.3	130	18.8	620	22.5	1860	26.8	4110	83
	35	17.2	50	21.9	380	26.7	1540	32.0	4090	37.9	8070	105
	40	22.7	120	28.7	650	34.8	3100	41.5	7320	49.1	13160	125
	45	28.3	280	35.4	1680	42.7	5350	50.9	11420	60.1	19020	144
	50	33.7	560	41.9	2920	50.4	8310	59.8	16190	70.6	25320	160
	55	39.1	1010	48.1	4650	57.6	11890	68.3	21400	80.6	31780	175
30	30	9.0	10	11.3	140	13.7	630	16.4	1810	19.4	3770	60
	35	13.7	50	17.0	420	20.5	1650	24.4	4120	28.8	7610	79
	40	18.7	150	23.0	1000	27.6	3400	32.8	7460	38.7	12510	98
	45	23.8	350	29.1	2000	34.8	5310	41.3	11610	48.6	18040	116
	50	28.9	700	35.1	3490	41.9	9090	49.6	16280	58.4	23900	132
	55	33.9	1280	41.0	5510	48.8	12800	57.6	21230	67.8	29820	147
	60	38.6	2140	45.6	[illegible]	55.3	16840	65.3	26270	76.7	35680	160
35	35	10.7	50	13.0	430	15.6	1600	18.5	3780	21.8	6620	60
	40	15.0	160	18.3	1050	21.8	3400	25.8	6960	30.4	11030	77
	45	19.6	390	23.7	2160	28.2	5940	33.4	10860	39.2	15040	93
	50	24.3	880	29.2	3800	34.7	9110	41.0	15210	48.1	21330	108
	55	28.9	1500	34.7	5980	41.1	12700	48.4	19760	56.9	26700	123
	60	33.5	2220	40.0	8620	47.3	16530	55.7	24360	65.4	32030	136
	65	38.0	3900	45.1	11600	53.3	20450	62.7	28890	73.6	37220	149
40	40	12.0	170	14.4	1040	17.1	3160	20.3	6120	23.8	9310	60
	45	16.0	420	19.2	2180	22.8	5590	26.9	9650	31.6	13720	75
	50	20.3	890	24.2	3860	28.7	8580	33.8	13570	39.7	18440	89
	55	24.5	1650	29.2	6060	34.5	11930	40.7	17690	47.7	23280	103
	60	28.8	2770	34.2	8880	40.4	15460	47.5	21860	55.7	28130	116
	65	33.0	4270	39.1	11530	46.0	19040	54.1	25990	63.4	32900	128
	70	37.1	8130	43.8	14540	51.5	22580	60.5	30030	70.9	37550	139
45	45	13.0	420	15.6	2080	18.4	5020	21.7	8290	25.5	11490	60
	50	16.8	910	20.0	3720	23.6	7750	27.8	11780	32.7	15650	73
	55	20.7	1720	24.6	5840	29.0	10900	34.1	15460	40.0	19990	86
	60	24.6	2890	29.2	8310	34.4	14000	40.4	19230	47.4	24380	98
	65	28.5	4440	33.7	10990	39.7	17260	46.6	23000	54.6	28770	110
	70	32.4	6300	38.2	13770	44.9	20490	52.7	26710	61.7	33080	121
	75	36.2	8410	42.6	16560	50.0	23650	58.6	30340	68.6	37300	132
50	50	13.9	900	16.5	3450	19.5	6820	22.9	10040	26.9	13130	60
	55	17.4	1710	20.6	5430	24.3	9540	28.6	13320	33.5	17000	72
	60	21.0	2890	24.9	7710	29.3	12430	34.4	16720	40.3	20980	83
	65	24.7	4420	29.1	10170	34.2	15380	40.1	20150	47.0	25000	94
	70	28.3	6540	33.3	12710	39.1	18330	45.9	23570	53.7	29000	105
	75	31.9	8350	37.5	15260	44.0	21240	51.5	26940	60.3	32950	116
	80	35.4	10370	41.5	17770	48.7	24080	57.0	30240	66.6	36810	125
55	55	14.6	1650	17.3	4910	20.4	8300	23.9	11370	28.1	14380	60
	60	17.9	2800	21.2	6990	24.9	10890	29.2	14420	34.2	17970	71
	65	21.3	4270	25.1	9230	29.5	13550	34.6	17540	40.5	21640	81
	70	24.7	5990	29.0	11540	34.1	16240	39.9	20690	46.7	25340	91
	75	28.0	7870	32.9	13860	38.6	18920	45.2	23820	52.9	29020	101
	80	31.4	9830	36.8	16160	43.1	21560	50.4	26910	59.0	32660	111
60	60	15.3	2630	18.0	6230	21.2	9450	24.8	12380	29.1	15350	60
	65	18.4	4020	21.6	8250	25.4	11860	29.8	15210	34.8	18690	70
	70	21.5	5620	25.3	10350	29.7	14310	34.7	18100	40.7	22100	79
	75	24.7	7360	29.0	12470	33.9	16780	39.7	21000	46.5	25530	89
	80	27.8	9160	32.6	14570	38.2	19230	44.7	23890	52.2	28940	98
65	65	15.8	3710	18.6	7310	21.9	10330	25.6	13160	30.0	16120	60
	70	18.7	5190	22.0	9210	25.8	12560	30.2	15800	35.4	19250	69
	75	21.7	6790	25.4	11140	29.8	14830	34.9	18490	40.8	22430	78
	80	24.6	8430	28.9	13080	33.8	17110	39.5	21190	46.2	25620	87
70	70	16.3	4730	19.2	8140	22.5	11000	26.3	13780	30.8	16750	60
	75	19.1	6190	22.3	9900	26.2	13080	30.6	16260	35.8	19690	68
	80	21.8	7690	25.6	11690	29.9	15190	35.0	18770	40.9	22670	77
75	75	16.7	5590	19.6	8780	23.0	11520	26.9	14280	31.4	17280	60
	80	19.3	6970	22.6	10420	26.5	13480	31.0	16610	36.2	20060	68
80	80	17.1	6280	20.0	9270	23.4	11940	27.4	14700	32.0	17740	60

TABLE 48.--CURRENT AND PROJECTED CORD(CS) AND BOARD FOOT INT. 1/4(BF) VOLUME AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX										PROJECTED BASAL AREA
		50		60		70		80		90		
YEARS		CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	SQ. FT.
70 SQ. FT. INITIAL BASAL AREA												
20	20	3.7	0	7.0	0	9.6	30	12.0	130	14.7	400	70
	25	8.6	0	13.9	30	18.2	160	22.4	570	27.0	1500	101
	30	14.1	10	21.5	100	27.6	490	33.8	1540	40.5	3670	128
	35	19.7	30	29.2	270	37.1	1130	45.1	3240	54.0	7030	152
	40	25.5	80	36.8	580	46.3	2220	56.1	5770	66.9	11560	173
	45	31.5	180	44.1	1110	55.0	3840	66.4	9170	79.0	17090	191
	50	37.7	350	51.1	1940	63.2	6100	76.1	13420	90.3	23410	207
25	25	7.6	0	10.5	30	13.1	180	16.0	620	19.1	1580	70
	30	12.8	10	17.1	120	21.1	600	25.5	1820	30.3	4100	95
	35	18.5	40	24.1	350	29.6	1450	35.5	3930	42.2	7990	117
	40	24.2	110	31.1	790	38.0	2880	45.5	7020	53.9	13030	138
	45	29.9	250	38.0	1520	46.2	4980	55.2	11000	65.3	18910	157
	50	35.5	490	44.7	2650	54.0	7770	64.4	15700	76.1	25310	173
	55	41.0	890	51.0	4230	61.4	11210	73.0	20930	86.2	31950	188
30	30	10.3	10	13.1	130	15.9	630	19.1	1860	22.6	3980	70
	35	15.3	50	19.2	410	23.2	1620	27.7	4170	32.8	7930	91
	40	20.6	140	25.6	950	30.8	3300	36.7	7500	43.3	12960	110
	45	25.9	320	32.0	1870	38.4	5720	45.6	11670	53.7	18690	128
	50	31.2	640	38.2	3250	45.7	8830	54.2	16420	63.9	24780	144
	55	36.4	1160	44.2	5150	52.8	12510	62.5	21520	73.5	30960	159
	60	41.4	1940	50.0	7580	59.5	16600	70.3	26750	82.7	37080	173
35	35	12.3	50	15.1	430	18.1	1650	21.5	4000	25.4	7200	70
	40	17.0	160	20.7	1040	24.8	3440	29.4	7300	34.7	11900	88
	45	21.9	370	26.6	2090	31.7	5980	37.5	11360	44.2	17210	105
	50	26.8	760	32.3	3670	38.5	9180	45.5	15900	53.5	22820	121
	55	31.6	1390	39.0	5770	45.2	12860	53.3	20680	62.6	28500	135
	60	36.3	2330	43.5	8370	51.6	16830	60.8	25520	71.4	34110	149
	65	40.9	3620	48.8	11370	57.7	20920	67.9	30300	79.8	39560	161
40	40	13.8	160	16.7	1060	19.9	3330	23.6	6670	27.8	10400	70
	45	18.2	410	21.9	2190	26.1	5850	30.8	10450	36.2	15180	86
	50	22.7	850	27.3	3850	32.3	8960	38.1	14640	44.8	20260	101
	55	27.2	1570	32.5	6050	38.5	12470	45.4	19030	53.3	25430	115
	60	31.7	2630	37.7	8690	44.6	16200	52.5	23470	61.6	30580	128
	65	36.0	4060	42.8	11640	50.5	19990	59.3	27850	69.6	35610	140
	70	40.3	5870	47.6	14780	56.1	23750	65.9	32110	77.3	40480	152
45	45	15.1	420	18.1	2160	21.4	5440	25.3	9250	29.7	13050	70
	50	19.2	900	22.9	3840	27.1	8360	31.9	13050	37.5	17600	84
	55	23.3	1680	27.8	6020	32.8	11620	38.6	17040	45.3	22290	97
	60	27.5	2820	32.6	8590	38.5	15050	45.3	21080	53.1	27000	110
	65	31.6	4340	37.4	11410	44.1	18540	51.8	25110	60.7	31650	122
	70	35.6	6210	42.1	14360	49.5	21990	58.1	29050	68.0	36200	134
	75	39.5	8350	46.6	17330	54.7	25350	64.2	32870	75.1	40620	144
50	50	16.1	910	19.2	3670	22.7	7560	26.7	11390	31.3	15080	70
	55	20.0	1720	23.7	5760	27.9	10530	32.8	14990	38.5	19310	83
	60	23.8	2900	28.2	8200	33.2	13670	39.0	18670	45.7	23620	95
	65	27.7	4450	32.7	10830	38.5	16850	45.1	22370	52.9	27920	106
	70	31.5	6310	37.1	13560	43.6	20020	51.1	26020	59.9	32170	117
	75	35.2	8400	41.4	16300	48.6	23130	57.0	29590	66.7	36330	128
	80	38.8	10640	45.6	18990	53.5	26150	62.6	33060	73.3	40370	138
55	55	17.0	1710	20.2	5360	23.8	9370	27.9	13040	32.7	16620	70
	60	20.6	2890	24.3	7620	28.6	12210	33.6	16390	39.4	20550	81
	65	24.2	4410	28.5	10050	33.5	15120	39.3	19780	46.1	24520	92
	70	27.8	6210	32.7	12560	38.4	18030	45.0	23160	52.7	28470	103
	75	31.3	8210	36.8	15070	43.2	20910	50.6	26490	59.2	32380	113
	80	34.8	10310	40.8	17550	47.9	23730	56.0	29760	65.5	36210	123
60	60	17.8	2790	21.0	6950	24.7	10800	28.9	14290	33.9	17810	70
	65	21.1	4260	24.9	9170	29.2	13450	34.3	17400	40.1	21460	80
	70	24.5	5970	28.8	11470	33.8	16130	39.6	20530	46.4	25140	91
	75	27.8	7840	32.7	13780	38.3	18790	44.9	23640	52.5	28810	101
	80	31.2	9800	36.5	16060	42.8	21420	50.1	26720	58.6	32430	110
65	65	18.4	4030	21.7	8270	25.5	11890	29.8	15260	34.9	18750	70
	70	21.6	5630	25.4	10370	29.7	14350	34.8	18150	40.8	22160	80
	75	24.7	7370	29.0	12490	34.0	16820	39.8	21060	46.6	25590	89
	80	27.9	9180	32.7	14600	38.3	19280	44.8	23950	52.4	29010	98
70	70	19.0	5240	22.3	9320	26.2	12730	30.6	16020	35.8	19510	70
	75	22.0	6840	25.8	11260	30.2	15010	35.3	18720	41.3	22720	79
	80	24.9	8510	29.2	13220	34.2	17310	40.0	21440	46.8	25930	88
75	75	19.5	6290	22.9	10120	26.8	13380	31.3	16630	36.6	20150	70
	80	22.3	7820	26.1	11920	30.6	15520	35.8	19170	41.8	23170	79
80	80	19.9	7150	23.4	10730	27.3	13900	32.0	17140	37.4	20690	70

TABLE 49.--CURRENT AND PROJECTED CORD(C5) AND BOARD FOOT INT. 1/4(BF) VOLUME AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX 50		60		70		80		90		PROJECTED BASAL AREA
YEARS		CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	SQ. FT.
		80 SQ. FT. INITIAL BASAL AREA										
20	20	3.3	0	7.6	0	10.7	30	13.6	130	16.6	390	80
	25	8.1	0	14.8	30	19.9	150	24.7	530	29.9	1420	112
	30	13.3	10	22.6	90	29.7	440	36.6	1420	44.0	3420	140
	35	18.7	30	30.5	240	39.5	1020	48.3	2960	57.9	6540	164
	40	24.4	70	38.2	520	48.9	1990	59.5	5280	71.2	10800	185
	45	30.4	160	45.6	990	57.7	3470	70.0	8450	83.5	16110	203
	50	37.0	310	52.7	1730	66.0	5540	79.8	12470	94.9	22300	219
25	25	8.2	0	11.7	30	14.9	170	18.1	610	21.7	1580	80
	30	13.6	10	18.7	120	23.4	560	28.3	1750	33.8	4010	106
	35	19.4	40	26.0	320	32.2	1350	38.8	3730	46.2	7760	129
	40	25.2	100	33.3	710	41.0	2650	49.2	6640	58.4	12680	150
	45	31.0	220	40.3	1380	49.4	4600	59.1	10460	70.1	18510	169
	50	36.8	440	47.1	2390	57.3	7210	68.5	15050	81.1	24940	185
	55	42.5	800	53.6	3840	64.9	10500	77.3	20230	91.4	31700	200
30	30	11.4	10	14.7	130	18.1	620	21.7	1870	25.7	4090	80
	35	16.7	50	21.3	380	25.9	1570	30.9	4120	36.7	8060	102
	40	22.2	130	28.0	880	33.9	3150	40.4	7330	47.7	13150	122
	45	27.7	290	34.6	1730	41.7	5450	49.6	11510	58.6	18990	140
	50	33.2	580	41.0	3000	49.3	8450	58.5	16290	69.0	25250	156
	55	38.5	1040	47.2	4780	56.5	12060	67.0	21470	78.9	31650	171
	60	43.7	1750	53.1	7070	63.3	16140	74.9	26850	88.2	38000	185
35	35	13.8	50	17.1	420	20.6	1650	24.5	4130	29.0	7630	80
	40	18.8	150	23.1	1000	27.8	3400	33.0	7470	38.9	12540	99
	45	23.9	340	29.2	1990	35.0	5900	41.5	11620	48.9	18080	116
	50	29.0	700	35.3	3480	42.1	9080	49.8	16290	58.6	23950	132
	55	34.0	1270	41.1	5500	49.0	12790	57.8	21250	68.1	29890	147
	60	38.9	2130	46.8	8020	55.5	16840	65.5	26300	77.1	35760	161
	65	43.6	3330	52.2	10990	61.8	21070	72.8	31300	85.6	41450	174
40	40	15.6	160	19.0	1060	22.7	3420	26.9	7080	31.7	11310	80
	45	20.3	390	24.6	2150	29.3	5970	34.6	11040	40.7	16420	96
	50	25.1	800	30.2	3770	35.8	9150	42.3	15450	49.8	21810	112
	55	29.8	1470	35.7	5930	42.3	12780	49.9	20070	58.6	27280	126
	60	34.4	2460	41.1	8560	48.6	16650	57.2	24740	67.2	32690	140
	65	38.9	3820	46.2	11550	54.6	20620	64.3	29350	75.4	37960	153
	70	43.2	5560	51.2	14780	60.4	24580	71.0	33830	83.3	43050	164
45	45	17.1	410	20.6	2190	24.4	5730	28.8	10060	33.9	14460	80
	50	21.5	870	25.7	3870	30.5	8790	35.9	14120	42.2	19360	95
	55	25.9	1610	30.9	6070	36.5	12230	43.0	18380	50.5	24370	109
	60	30.2	2710	35.9	8700	42.4	15850	49.9	22680	58.6	29360	122
	65	34.5	4180	40.9	11610	48.2	19540	56.7	26940	66.5	34260	134
	70	38.6	6010	45.7	14690	53.8	23200	63.2	31090	74.0	39030	146
	75	42.7	8170	50.3	17830	59.2	26750	69.4	35090	81.3	43620	156
50	50	18.3	900	21.9	3810	25.9	8160	30.4	12610	35.7	16920	80
	55	22.4	1700	26.6	5970	31.5	11350	37.0	16500	43.4	21480	93
	60	26.5	2850	31.4	8510	37.0	14700	43.5	20450	51.0	26080	106
	65	30.5	4380	36.1	11290	42.5	18110	49.9	24380	58.5	30650	118
	70	34.5	6250	40.7	14180	47.9	21480	56.2	28240	65.8	35110	129
	75	38.4	8400	45.2	17090	53.1	24780	62.2	31990	72.8	39460	140
	80	42.1	10720	49.5	19950	58.1	27970	68.0	35620	79.6	43660	150
55	55	19.4	1720	23.0	5700	27.1	10320	31.8	14610	37.3	18780	80
	60	23.2	2910	27.4	8100	32.3	13390	37.9	18230	44.5	23010	92
	65	27.0	4450	31.9	10700	37.5	16530	44.0	21860	51.5	27250	104
	70	30.7	6300	36.2	13380	42.6	19640	49.9	25460	58.5	31440	115
	75	34.4	8380	40.5	16070	47.5	22710	55.7	28990	65.2	35550	125
	80	38.1	10590	44.7	18720	52.4	25690	61.3	32420	71.8	39550	135
60	60	20.2	2880	23.9	7540	28.1	12050	33.0	16140	38.7	20210	80
	65	23.8	4400	28.1	9950	33.0	14930	38.7	19490	45.3	24150	91
	70	27.4	6190	32.2	12430	37.8	17810	44.4	22840	51.9	28070	102
	75	30.9	8170	36.3	14920	42.6	20660	49.9	26150	58.4	31950	112
	80	34.4	10260	40.3	17380	47.2	23450	55.3	29400	64.7	35760	122
65	65	21.0	4250	24.7	9130	29.1	13380	34.1	17300	39.9	21340	80
	70	24.4	5960	28.7	11420	33.6	16050	39.4	20420	46.1	25010	90
	75	27.7	7830	32.5	13720	38.1	18710	44.7	23530	52.3	28670	100
	80	31.0	9770	36.4	16000	42.6	21330	49.9	26600	58.3	32280	110
70	70	21.7	5640	25.5	10410	29.9	14410	35.0	18220	40.9	22250	80
	75	24.8	7390	29.1	12530	34.2	16880	40.0	21130	46.8	25690	89
	80	28.0	9200	32.8	14650	38.4	19340	44.9	24040	52.5	29110	99
75	75	22.2	6900	26.1	11390	30.6	15200	35.8	18960	41.9	23000	80
	80	25.2	8580	29.6	13360	34.6	17510	40.5	21690	47.3	26240	89
80	80	22.8	7940	26.7	12150	31.2	15830	36.5	19560	42.7	23640	80

TABLE 50.--CURRENT AND PROJECTED CORD(CS) AND BOARD FOOT INT. 1/4(BF) VOLUME AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX										PROJECTED BASAL AREA
		50		60		70		80		90		
YEARS		CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	SQ. FT.
90 SQ. FT. INITIAL BASAL AREA												
20	20	2.4	0	8.0	0	11.8	30	15.1	120	18.6	380	90
	25	6.7	0	15.5	20	21.4	140	26.9	500	32.6	1330	123
	30	11.4	10	23.4	80	31.5	400	39.2	1300	47.3	3170	151
	35	16.3	20	31.3	210	41.5	920	51.3	2690	61.7	6050	176
	40	21.8	60	39.0	460	51.1	1790	62.7	4810	75.1	10040	196
	45	28.1	140	46.5	880	60.0	3130	73.3	7750	87.6	15100	214
	50	35.2	280	53.8	1550	68.4	5030	83.1	11550	99.1	21100	229
25	25	8.6	0	12.8	30	16.5	170	20.2	600	24.3	1550	90
	30	14.1	10	20.2	110	25.5	530	31.0	1650	37.1	3870	117
	35	19.8	30	27.7	290	34.7	1240	42.0	3500	50.1	7440	141
	40	25.7	90	35.2	650	43.7	2440	52.7	6230	62.7	12190	162
	45	31.6	200	42.3	1240	52.3	4220	62.8	9850	74.6	17390	180
	50	37.5	390	49.2	2160	60.4	6660	72.3	14280	85.7	24300	196
	55	43.5	710	55.8	3480	68.0	9770	81.2	19390	96.1	31130	211
30	30	12.4	10	16.4	130	20.2	610	24.3	1840	28.9	4110	90
	35	18.0	40	23.2	360	28.4	1490	34.1	4010	40.4	8040	112
	40	23.6	120	30.2	820	36.7	2970	43.9	7150	52.0	13110	133
	45	29.3	260	37.0	1590	44.8	5140	53.4	11190	63.2	19000	151
	50	34.8	520	43.5	2760	52.6	8000	62.6	15930	73.9	25360	168
	55	40.3	940	49.8	4400	59.9	11500	71.2	21150	84.0	31930	183
	60	45.6	1580	55.8	6560	66.9	15530	79.2	26640	93.4	38570	196
35	35	15.2	50	19.1	410	23.1	1630	27.5	4170	32.5	7910	90
	40	20.5	140	25.4	950	30.6	3310	36.4	7500	43.0	12940	109
	45	25.8	320	31.8	1880	38.2	5730	45.3	11670	53.4	18660	127
	50	31.1	640	38.0	3270	45.5	8850	53.9	16420	63.6	24740	144
	55	36.2	1160	44.0	5180	52.5	12530	62.2	21510	73.2	30910	159
	60	41.2	1950	49.8	7600	59.3	16620	70.0	26730	82.4	37010	172
	65	46.1	3060	55.3	10500	65.6	20950	77.4	31930	91.0	42930	185
40	40	17.4	150	21.2	1030	25.4	3430	30.2	7350	35.6	12050	90
	45	22.3	370	27.1	2070	32.4	5980	38.3	11430	45.1	17410	107
	50	27.2	750	33.0	3630	39.2	9180	46.4	16000	54.6	23080	123
	55	32.1	1370	38.7	5720	45.9	12860	54.2	20820	63.8	28810	138
	60	36.9	2290	44.2	8310	52.4	16850	61.8	25710	72.6	34470	151
	65	41.5	3560	49.5	11300	58.6	20970	69.0	30530	81.0	39970	164
	70	46.0	5220	54.6	14580	64.5	25110	75.8	35210	88.9	45260	176
45	45	19.1	400	23.0	2170	27.4	5910	32.3	10710	38.1	15710	90
	50	23.7	830	28.5	3830	33.8	9060	39.8	15000	46.8	20920	105
	55	28.3	1530	33.8	6010	40.1	12620	47.2	19490	55.5	26220	120
	60	32.8	2560	39.1	8650	46.2	16410	54.4	24020	63.9	31470	133
	65	37.2	3970	44.2	11630	52.2	20280	61.4	28500	72.0	36610	145
	70	41.5	5750	49.1	14830	57.9	24130	68.0	32850	79.8	41570	157
	75	45.6	7880	53.9	18080	63.4	27870	74.4	37030	87.1	46330	168
50	50	20.5	880	24.5	3870	29.0	8630	34.2	13680	40.2	18620	90
	55	24.8	1640	29.5	6060	34.9	11990	41.1	17830	48.3	23500	104
	60	29.1	2760	34.5	8670	40.8	15540	47.9	22020	56.2	28370	117
	65	33.3	4250	39.4	11550	46.5	19140	54.6	26180	64.0	33170	129
	70	37.4	6110	44.2	14380	52.0	22710	61.0	30240	71.5	37840	141
	75	41.4	8260	48.7	17540	57.3	26190	67.2	34170	78.7	42360	151
	80	45.2	10640	53.2	20670	62.4	29540	73.1	37950	85.6	46700	162
55	55	21.7	1710	25.8	5920	30.4	11120	35.8	16060	42.0	20850	90
	60	25.7	2870	30.5	8430	35.9	14410	42.2	19940	49.5	25360	102
	65	29.7	4410	35.1	11170	41.3	17750	48.5	23800	56.9	29850	114
	70	33.6	6280	39.6	14010	46.6	21070	54.7	27600	64.1	34250	126
	75	37.4	8410	44.1	16870	51.8	24310	60.7	31300	71.0	38540	136
	80	41.2	10710	48.4	19690	56.7	27450	66.4	34880	77.7	42700	147
60	60	22.7	2910	26.8	8020	31.6	13180	37.1	17890	43.5	22550	90
	65	26.5	4450	31.2	10590	36.7	16270	43.1	21480	50.5	26740	101
	70	30.2	6290	35.6	13240	41.8	19350	49.0	25040	57.4	30890	112
	75	33.9	8360	39.8	15900	46.7	22380	54.8	28530	64.1	34970	123
	80	37.4	10550	44.0	18520	51.5	25330	60.3	31930	70.6	38940	133
65	65	23.5	4390	27.8	9880	32.6	14790	38.3	19290	44.8	23890	90
	70	27.1	6170	31.9	12350	37.5	17650	43.9	22620	51.4	27790	101
	75	30.6	8150	36.0	14820	42.2	20490	49.4	25920	57.8	31650	111
	80	34.1	10220	40.0	17260	46.8	23260	54.8	29150	64.1	35440	121
70	70	24.3	5950	28.6	11410	33.6	16020	39.3	20380	46.0	24960	90
	75	27.6	7820	32.5	13700	38.1	18680	44.6	23490	52.2	28610	100
	80	31.0	9760	36.3	15980	42.5	21300	49.8	26560	58.2	32230	109
75	75	25.0	7420	29.3	12600	34.4	16980	40.2	21260	47.0	25840	90
	80	28.1	9230	33.0	14720	38.6	19450	45.2	24170	52.8	29280	99
80	80	25.6	8660	30.0	13520	35.1	17730	41.0	21970	48.0	26580	90

TABLE 51.--CURRENT AND PROJECTED CORD(C5) AND BOARD FOOT INT. 1/4(BF) VOLUME AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX										PROJECTED BASAL AREA
		50		60		70		80		90		
YEARS		CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	SQ. FT.
100 SQ. FT. INITIAL BASAL AREA												
20	20	.7	0	8.2	0	12.7	30	16.6	120	20.5	360	100
	25	4.3	0	15.8	20	22.7	130	28.9	460	35.3	1240	134
	30	7.9	10	23.7	70	33.1	370	41.6	1180	50.5	2310	162
	35	12.0	20	31.6	190	43.3	830	53.9	2450	65.1	5560	186
	40	17.2	60	39.3	410	52.9	1620	65.5	4380	78.8	9290	207
	45	23.9	120	47.0	790	62.0	2830	76.2	7110	91.4	14090	224
	50	31.9	250	54.5	1400	70.5	4570	86.1	10680	103.0	19890	239
25	25	8.6	0	13.9	30	18.1	160	22.3	570	26.9	1500	100
	30	14.1	10	21.4	100	27.5	490	33.6	1550	40.3	3680	127
	35	19.8	30	29.2	270	37.0	1140	45.0	3250	53.8	7050	152
	40	25.6	80	36.7	580	46.2	2230	55.9	5790	66.7	11590	173
	45	31.5	180	44.0	1120	54.9	3860	66.2	9210	78.8	17140	191
	50	37.7	350	51.0	1950	63.1	6130	75.9	13470	90.1	23460	207
	55	44.0	640	57.7	3160	70.8	9060	84.8	18450	100.5	30320	221
30	30	13.3	10	17.9	120	22.2	580	26.8	1790	32.0	4070	100
	35	18.9	40	25.0	340	30.9	1400	37.1	3840	44.1	7890	123
	40	24.7	110	32.2	750	39.5	2780	47.3	6850	56.1	12890	144
	45	30.5	240	39.2	1450	47.8	4800	57.1	10750	67.6	18750	162
	50	36.2	470	45.9	2520	55.7	7510	66.4	15410	78.5	25170	179
	55	41.8	840	52.3	4040	63.1	10880	75.1	20620	88.7	31870	194
	60	47.3	1420	58.4	6060	70.1	14920	83.2	26180	98.2	38530	207
35	35	16.5	50	21.0	390	25.5	1580	30.5	4130	36.1	8050	100
	40	22.0	130	27.6	890	33.4	3180	39.8	7410	47.1	13140	120
	45	27.5	290	34.2	1750	41.2	5490	49.0	11550	57.9	18970	138
	50	32.9	580	40.6	3040	48.7	8510	57.9	16320	68.3	25200	155
	55	38.2	1060	46.7	4840	55.9	12130	66.3	21500	78.1	31570	170
	60	43.3	1780	52.6	7150	62.8	16220	74.2	26960	87.4	37690	183
	65	48.3	2790	58.2	9960	69.2	20610	81.7	32240	96.2	44040	196
40	40	19.0	150	23.4	1000	28.1	3330	33.4	7480	39.4	12600	100
	45	24.2	340	29.6	1980	35.4	5890	42.0	11630	49.5	18170	118
	50	29.3	600	35.6	3450	42.5	9060	50.3	16320	59.3	24060	134
	55	34.3	1260	41.5	5460	49.4	12760	58.4	21300	68.7	30040	149
	60	39.2	2110	47.2	7970	55.0	16820	66.1	26370	77.7	35930	162
	65	44.0	3300	52.6	10930	62.3	21070	73.4	31330	86.3	41650	175
	70	48.5	4860	57.8	14230	68.3	25360	80.4	36260	94.3	47140	186
45	45	21.0	380	25.4	2130	30.3	5980	35.9	11190	42.2	16780	100
	50	25.8	780	31.1	3730	37.0	9180	43.7	15660	51.4	22270	116
	55	30.6	1440	36.7	5870	43.6	12830	51.4	20360	60.4	27830	130
	60	35.2	2400	42.1	8490	49.9	16750	58.8	25100	69.1	33330	144
	65	39.8	3740	47.4	11480	56.0	20770	65.9	29790	77.3	38680	156
	70	44.2	5450	52.4	14730	61.8	24790	72.7	34330	85.2	43830	168
	75	48.4	7520	57.2	18110	67.4	28720	79.1	38700	92.7	48760	179
50	50	22.6	850	27.1	3860	32.2	8950	37.9	14590	44.6	20180	100
	55	27.1	1570	32.4	6050	38.3	12450	45.2	18970	53.0	25340	114
	60	31.5	2940	37.6	8690	44.4	16170	52.2	23400	61.3	30470	127
	65	35.9	4080	42.6	11640	50.3	19950	59.1	27760	69.3	35490	140
	70	40.1	5890	47.5	14780	55.9	23700	65.7	32050	77.0	40350	152
	75	44.2	8030	52.2	17980	61.3	27360	72.0	36110	84.3	45030	162
	80	48.1	10430	56.7	21170	66.5	30880	78.0	40040	91.3	49510	173
55	55	24.0	1670	28.5	6040	33.7	11780	39.7	17380	46.6	22800	100
	60	28.2	2800	33.4	8630	39.5	15270	46.4	21490	54.4	27580	113
	65	32.3	4310	38.3	11480	45.1	18800	53.0	25570	62.1	32300	125
	70	36.4	6170	43.0	14460	50.5	22300	59.3	29560	69.5	36900	137
	75	40.3	8320	47.5	17470	55.8	25710	65.4	33430	76.6	41360	147
	80	44.1	10680	51.9	20450	60.9	29010	71.3	37150	83.5	45650	158
60	60	25.1	2890	29.7	8370	35.1	14190	41.2	19540	48.3	24820	100
	65	29.0	4430	34.3	11070	40.4	17480	47.4	23350	55.6	29240	112
	70	32.9	6300	38.8	13880	45.7	20750	53.6	27100	62.7	33600	123
	75	36.7	8420	43.2	16700	50.8	23940	59.5	30760	69.7	37850	134
	80	40.4	10700	47.5	19480	55.7	27050	65.2	34310	76.3	41970	144
65	65	26.1	4450	30.8	10510	36.2	16090	42.5	21200	49.8	26380	100
	70	29.8	6290	35.1	13140	41.2	19140	48.4	24730	56.6	30500	111
	75	33.4	8340	39.3	15770	46.2	22150	54.1	28200	63.3	34550	121
	80	37.0	10520	43.5	18370	50.9	25070	59.6	31580	69.8	38500	131
70	70	26.9	6160	31.7	12300	37.2	17560	43.6	22500	51.1	27630	100
	75	30.4	8130	35.8	14760	42.0	20380	49.1	25780	57.5	31480	110
	80	33.9	10200	39.8	17190	46.6	23150	54.5	29000	63.8	35260	120
75	75	27.7	7820	32.5	13720	38.1	18700	44.6	23520	52.2	28650	100
	80	31.0	9770	36.4	15990	42.6	21320	49.8	26590	58.3	32270	110
80	80	28.3	9280	33.2	14820	38.9	19590	45.5	24350	53.2	29500	100

TABLE 52.--CURRENT AND PROJECTED CORD(CS) AND BOARD FOOT INT. 1/4(BF) VOLUME AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX										PROJECTED BASAL AREA
		50		60		70		80		90		
YEARS		CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	SQ. FT.
110 SQ. FT. INITIAL BASAL AREA												
20	20			8.1	0	13.5	30	17.9	110	22.3	340	110
	25	.1	0	15.6	20	23.8	120	30.8	420	37.8	1140	144
	30	2.0	10	23.5	70	34.5	330	43.8	1080	53.4	2670	173
	35	4.8	20	31.3	170	44.7	750	56.4	2220	68.4	5100	197
	40	9.6	50	39.1	370	54.5	1460	68.1	3990	82.2	8560	217
	45	17.1	110	46.9	710	63.7	2560	78.9	6510	95.0	13100	234
	50	26.8	220	54.7	1260	72.3	4170	88.9	9870	106.6	16680	249
25	25	8.2	0	14.7	30	19.6	150	24.3	540	29.4	1430	110
	30	13.5	10	22.5	90	29.4	450	36.1	1440	43.4	3470	138
	35	18.9	30	30.3	240	39.1	1040	47.8	3010	57.3	6630	162
	40	24.6	70	38.0	530	48.5	2030	59.0	5360	70.5	10930	183
	45	30.7	160	45.3	1010	57.3	3530	69.4	8570	82.8	16280	201
	50	37.2	320	52.5	1760	65.6	5630	79.2	12630	94.2	22490	217
	55	43.9	570	59.3	2870	73.3	8390	88.2	17460	104.7	29320	231
30	30	13.8	10	19.3	110	24.2	550	29.4	1710	35.0	3960	110
	35	19.6	40	26.7	310	33.2	1310	40.1	3640	47.7	7650	134
	40	25.4	100	34.0	690	42.0	2580	50.6	6490	60.1	12510	155
	45	31.3	210	41.1	1320	50.5	4450	60.6	10230	71.8	18290	173
	50	37.1	420	47.9	2300	58.5	7000	70.0	14760	82.9	24720	189
	55	42.9	760	54.5	3700	66.1	10220	78.8	19920	93.2	31510	204
	60	48.6	1280	60.7	5590	73.2	14050	87.0	25510	102.8	38430	217
35	35	17.7	40	22.8	370	27.9	1510	33.4	4040	39.6	8060	110
	40	23.3	120	29.7	830	36.1	3020	43.1	7210	51.0	13140	130
	45	28.9	270	36.4	1620	44.1	5210	52.6	11280	62.2	19020	149
	50	34.5	530	43.0	2810	51.3	8100	61.6	16030	72.8	25360	165
	55	39.9	960	49.2	4490	59.2	11630	70.2	21250	82.8	31900	180
	60	45.2	1610	55.2	6680	66.1	15680	78.3	26720	92.2	38420	194
	65	50.3	2550	60.9	9380	72.6	20090	85.9	32250	101.0	44790	206
40	40	20.6	140	25.6	950	30.8	3300	36.6	7500	43.3	12960	110
	45	25.9	320	31.9	1870	38.4	5720	45.5	11670	53.7	18690	128
	50	31.2	640	38.2	3250	45.7	8830	54.2	16420	63.8	24770	144
	55	36.3	1160	44.2	5160	52.8	12510	62.4	21520	73.5	30960	159
	60	41.4	1940	50.0	7580	59.5	16600	70.3	26750	82.7	37070	173
	65	46.2	3040	55.5	10470	65.9	20930	77.7	31960	91.3	43010	186
	70	50.9	4510	60.7	13750	71.9	25360	84.7	37040	99.5	48700	197
45	45	22.8	360	27.8	2050	33.2	5960	39.3	11510	46.3	17650	110
	50	27.8	730	33.7	3580	40.2	9160	47.5	16120	55.9	23380	126
	55	32.8	1340	39.5	5950	46.9	12850	55.4	20990	65.2	29190	141
	60	37.6	2240	45.0	8220	53.4	16960	63.0	25920	74.1	34920	155
	65	42.2	3490	50.4	11210	59.6	21030	70.2	30800	82.5	40480	167
	70	46.7	5120	55.5	14500	65.6	25210	77.1	35540	90.5	45820	179
	75	51.0	7130	60.4	17960	71.2	29310	83.6	40090	98.0	50920	189
50	50	24.7	810	29.7	3790	35.3	9130	41.6	15330	48.9	21570	110
	55	29.3	1490	35.2	5960	41.7	12740	49.1	19920	57.8	26990	124
	60	33.9	2490	40.5	8530	47.9	16590	56.4	24550	66.3	32360	138
	65	38.4	3860	45.7	11590	54.0	20540	63.5	29120	74.5	37590	151
	70	42.7	5620	50.7	14800	59.7	24460	70.2	33560	82.3	42640	162
	75	46.9	7720	55.4	18120	65.2	28290	76.6	37830	89.7	47480	173
	80	50.9	10120	60.0	21450	70.5	31980	82.6	41910	96.8	52090	183
55	55	26.2	1600	31.3	6070	37.0	12290	43.6	18540	51.1	24630	110
	60	30.6	2690	36.4	8700	43.0	15940	50.5	22880	59.3	29660	123
	65	34.9	4150	41.3	11630	48.8	19660	57.3	27160	67.2	34590	136
	70	39.0	5980	46.2	14720	54.4	23330	63.8	31340	74.8	39380	147
	75	43.1	8130	50.8	17670	59.7	26920	70.1	35370	82.1	43990	158
	80	47.0	10530	55.3	21000	64.9	30370	76.1	39230	89.0	48420	168
60	60	27.5	2820	32.6	8590	38.5	15050	45.2	21070	53.0	26980	110
	65	31.6	4340	37.4	11410	44.0	18530	51.7	25090	60.6	31630	122
	70	35.6	6210	42.0	14350	49.5	21980	58.0	29030	68.0	36180	134
	75	39.5	8360	46.6	17330	54.7	25340	64.1	32850	75.1	40590	144
	80	43.3	10700	50.9	20260	59.7	28500	70.0	36540	81.9	44850	155
65	65	28.6	4440	33.8	11000	39.8	17270	46.7	23030	54.7	28810	110
	70	32.4	6300	38.3	13780	45.0	20510	52.8	26750	61.8	33130	121
	75	36.2	8410	42.6	16570	50.1	23680	58.7	30370	68.7	37340	132
	80	39.9	10680	46.9	19320	55.0	26750	64.4	33900	75.3	41440	142
0	70	29.5	6280	34.8	13070	40.9	19010	47.9	24540	56.1	30260	110
	75	33.2	8330	39.0	15690	45.8	22000	53.7	27990	62.8	34290	120
	80	36.7	10500	43.1	18270	50.6	24910	59.2	31360	69.3	38220	130
75	75	30.4	8130	35.7	14740	41.9	20360	49.1	25740	57.4	31430	110
	80	33.8	10190	39.7	17170	46.5	23120	54.4	28960	63.7	35210	120
80	80	31.1	9790	36.5	16050	42.8	21410	50.1	26700	58.5	32410	110

TABLE 53.--CURRENT AND PROJECTED CORD(C5) AND BOARD FOOT INT. 1/4(BF) VOLUME AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX 50 CDS.	50 FBM.	60 CDS.	60 FBM.	70 CDS.	70 FBM.	80 CDS.	80 FBM.	90 CDS.	90 FBM.	PROJECTED BASAL AREA
YEARS												SQ. FT.
120 SQ. FT. INITIAL BASAL AREA												
20	20			7.7	0	14.2	20	19.2	110	24.1	320	120
	25			15.0	20	24.7	110	32.5	380	40.1	1050	155
	30			22.5	60	35.5	300	45.9	980	56.2	2440	183
	35			30.2	150	45.9	670	58.6	2010	71.4	4670	207
	40			38.0	330	55.7	1310	70.4	3630	85.4	7880	227
	45	6.4	100	46.1	640	65.0	2320	81.3	5960	98.2	12160	243
	50	18.9	200	54.3	1140	73.8	3800	91.4	9120	109.9	17510	257
25	25	7.2	0	15.3	20	21.0	140	26.3	510	31.9	1360	120
	30	12.0	10	23.2	80	31.1	410	38.5	1330	46.5	3240	148
	35	17.1	30	31.1	220	41.0	950	50.5	2760	60.7	6180	173
	40	22.6	70	38.8	480	50.5	1850	61.9	4930	74.1	10240	193
	45	28.8	140	46.3	910	59.4	3220	72.4	7930	86.6	15370	211
	50	35.8	280	53.6	1600	67.8	5160	82.2	11790	98.0	21430	227
	55	43.1	520	60.6	2610	75.7	7750	91.3	16460	108.6	28200	240
30	30	14.1	10	20.6	110	26.1	520	31.8	1620	38.1	3810	120
	35	19.9	30	28.2	290	35.4	1210	42.9	3420	51.2	7330	144
	40	25.7	90	35.7	630	44.5	2370	53.7	6090	63.9	12010	165
	45	31.6	190	42.9	1200	53.1	4110	63.9	9050	75.9	17680	183
	50	37.6	380	49.8	2090	61.2	6500	73.4	14040	87.1	24060	200
	55	43.7	690	56.4	3380	68.8	9550	82.3	19110	97.5	30900	214
	60	49.7	1160	62.7	5140	76.0	13250	90.6	24680	107.1	37950	227
35	35	18.7	40	24.5	340	30.2	1430	36.2	3990	43.0	7950	120
	40	24.4	110	31.6	770	38.7	2830	46.3	6940	54.9	12970	141
	45	30.1	240	38.6	1490	46.9	4900	56.1	10890	66.4	18840	159
	50	35.8	480	45.2	2590	54.8	7650	65.3	15570	77.2	25250	176
	55	41.4	870	51.6	4150	62.2	11050	74.0	20790	87.4	31920	191
	60	46.8	1470	57.7	6210	69.2	15040	82.1	26340	96.8	38630	204
	65	52.1	2320	63.4	8790	75.8	19440	89.7	32000	105.7	45210	216
40	40	22.0	130	27.6	890	33.4	3180	39.8	7410	47.1	13140	120
	45	27.5	290	34.2	1750	41.2	5490	49.0	11540	57.9	18970	138
	50	32.9	580	40.6	3040	48.8	8510	57.9	16320	68.3	25200	155
	55	39.2	1060	46.7	4830	56.0	12130	66.3	21500	78.2	31570	170
	60	43.3	1770	52.6	7150	62.8	16220	74.3	26960	87.5	37300	183
	65	48.3	2790	58.2	9950	69.2	20610	81.8	32240	96.2	44050	196
	70	53.1	4160	63.6	13190	75.3	25140	88.9	37510	104.4	49940	207
45	45	24.6	340	30.1	1950	36.1	5850	42.8	11660	50.5	18320	120
	50	29.8	680	36.2	3410	43.3	9020	51.2	16370	60.4	24250	136
	55	34.8	1240	42.1	5330	50.2	12720	59.4	21360	69.9	30280	151
	60	39.7	2070	47.9	7880	56.8	16790	67.1	26490	78.9	36230	165
	65	44.5	3240	53.3	10830	63.2	21060	74.4	31550	87.5	42000	177
	70	49.1	4780	58.5	14120	69.1	25330	81.4	36480	95.6	47540	189
	75	53.5	6710	63.4	17640	74.8	29650	87.9	41210	103.2	52800	200
50	50	26.7	760	32.2	3670	38.3	9190	45.3	15880	53.3	22760	120
	55	31.5	1390	37.9	5730	45.0	12860	53.1	20650	62.4	28430	135
	60	36.2	2330	43.4	8330	51.4	16820	60.6	25480	71.2	34030	148
	65	40.8	3630	48.7	11390	57.5	20910	67.7	30250	79.5	39470	161
	70	45.2	5310	53.7	14650	63.4	24990	74.5	34870	87.5	44700	173
	75	49.5	7360	58.6	18070	69.0	29000	81.0	39310	95.0	49700	183
	80	53.6	9740	63.2	21530	74.3	32950	87.1	43540	102.1	54450	193
55	55	28.4	1530	34.0	6010	40.2	12640	47.4	19530	55.7	26300	120
	60	32.9	2550	39.2	8650	46.4	16430	54.6	24080	64.1	31560	133
	65	37.3	3960	44.4	11620	52.4	20310	61.6	28560	72.3	36710	146
	70	41.6	5740	49.3	14810	58.1	24160	68.2	32920	80.0	41680	158
	75	45.8	7860	54.0	18080	63.6	27920	74.6	37110	87.4	46440	168
	80	49.7	10270	58.6	21350	68.8	31530	80.6	41130	94.4	51000	179
60	60	29.8	2720	35.5	8690	41.9	15750	49.3	22460	57.8	29030	120
	65	34.1	4200	40.4	11600	47.6	19410	56.0	26690	65.6	33900	132
	70	38.2	8050	45.2	14660	53.2	23040	62.4	30800	73.2	38630	144
	75	42.2	8200	49.8	17770	58.5	26570	68.7	34790	80.4	43200	155
	80	46.1	10590	54.2	20850	63.7	29970	74.6	38610	87.3	47580	165
65	65	31.1	4360	36.8	11350	43.3	18320	50.8	24740	59.6	31150	120
	70	35.1	6230	41.4	14270	48.7	21740	57.1	28640	66.9	35660	131
	75	38.9	8380	45.9	17210	53.9	25070	63.2	32430	74.0	40040	142
	80	42.7	10710	50.2	20110	58.9	28290	69.0	36090	80.8	44260	152
70	70	32.1	6300	37.9	13710	44.5	20350	52.2	26510	61.2	32820	120
	75	35.9	8410	42.2	16490	49.6	23500	58.1	30120	68.0	37020	131
	80	39.6	10670	46.5	19210	54.5	26560	63.8	33630	74.7	41090	141
75	75	33.1	8320	38.9	15650	45.6	21930	53.5	27900	62.6	34170	120
	80	36.6	10490	43.0	18230	50.4	24840	59.0	31260	69.0	38100	130
80	80	33.9	10200	39.8	17190	46.6	23170	54.6	29020	63.8	35280	120

TABLE 54.--CURRENT AND PROJECTED CORD(C5) AND BOARD FOOT INT. 1/4(BF) VOLUME AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

130 SQ. FT. INITIAL BASAL AREA

INITIAL AGE	FINAL AGE	SITE INDEX 50		60		70		80		90		PROJECTED BASAL AREA
YEARS		CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	SQ. FT.
20	20			6.6	0	14.6	20	20.4	100	25.8	300	130
	25			13.5	20	25.4	100	34.1	350	42.4	960	165
	30			20.7	50	36.2	270	47.7	880	58.8	2220	193
	35			28.1	140	46.7	610	60.6	1820	74.3	4260	217
	40			36.0	300	56.6	1190	72.5	3300	88.4	7240	236
	45			44.4	580	66.0	2110	83.5	5470	101.3	11280	252
	50	6.9	180	53.2	1040	74.9	3480	93.6	8420	113.0	16390	266
25	25	5.3	0	15.7	20	22.3	130	28.2	470	34.4	1270	130
	30	9.4	10	23.6	80	32.6	380	40.8	1220	49.4	3000	159
	35	13.8	20	31.6	200	42.7	860	53.0	2530	63.9	5730	183
	40	19.1	60	39.3	430	52.3	1680	64.5	4530	77.5	9550	203
	45	25.6	130	46.9	820	61.4	2930	75.2	7330	90.1	14440	221
	50	33.2	260	54.3	1450	69.8	4730	85.1	10980	101.7	20310	236
	55	41.6	470	61.6	2380	77.8	7150	94.2	15470	112.2	26980	249
30	30	14.0	10	21.7	100	28.0	480	34.2	1520	41.1	3630	130
	35	19.6	30	29.5	260	37.5	1120	45.7	3190	54.6	6950	154
	40	25.4	80	37.0	570	46.8	2180	56.7	5690	67.6	11440	175
	45	31.4	170	44.4	1090	55.5	3780	67.0	9050	79.8	16940	193
	50	37.6	340	51.4	1900	63.7	6000	76.7	13260	91.1	23240	209
	55	44.0	620	58.1	3090	71.4	8900	85.6	18210	101.6	30090	223
	60	50.4	1050	64.6	4720	78.6	12450	93.9	23740	111.2	37230	236
35	35	19.4	40	26.2	320	32.4	1340	39.1	3710	46.5	7740	130
	40	25.2	100	33.4	710	41.2	2640	49.5	6520	58.7	12650	151
	45	31.0	220	40.5	1370	49.6	4570	59.4	10420	70.4	18470	169
	50	36.8	440	47.3	2390	57.6	7170	68.8	15000	81.4	24900	186
	55	42.6	790	53.7	3920	65.1	10450	77.6	20180	91.7	31670	201
	60	49.2	1330	59.9	5750	72.2	14320	85.8	25750	101.2	38530	214
	65	53.7	2120	65.8	8200	78.8	18680	93.4	31530	110.1	45310	225
40	40	23.3	120	29.6	830	36.0	3020	43.0	7220	50.9	13140	130
	45	28.9	270	36.4	1620	44.0	5220	52.5	11290	62.0	19020	148
	50	34.4	530	42.9	2920	51.7	8120	61.5	16040	72.6	25360	165
	55	39.8	960	49.2	4500	59.0	11650	70.1	21260	82.7	31890	180
	60	45.1	1620	55.1	6690	66.0	15700	78.1	26730	92.1	38410	193
	65	50.2	2560	60.8	9400	72.5	20110	85.7	32260	100.9	44770	206
	70	55.2	3840	66.2	12560	78.6	24730	92.8	37710	109.1	50880	217
45	45	26.2	310	32.4	1840	38.9	5680	46.2	11650	54.0	18760	130
	50	31.5	630	38.7	3210	46.3	8770	54.9	16420	64.7	24880	146
	55	36.7	1140	44.7	5090	53.4	12440	63.2	21530	74.5	31110	161
	60	41.8	1900	50.5	7490	60.2	16540	71.1	26790	83.7	37260	175
	65	46.7	2990	56.0	10370	66.5	20880	78.5	32040	92.3	43240	188
	70	51.4	4440	61.3	13640	72.6	25330	85.5	37160	100.5	48970	199
	75	55.9	6280	65.3	17190	78.3	29760	92.1	42070	108.1	54420	209
50	50	28.6	710	34.7	3520	41.4	9120	49.0	16240	57.6	23750	130
	55	33.6	1300	40.5	5560	48.2	12820	57.0	21170	67.0	29640	145
	60	38.4	2170	46.1	8100	54.8	16860	64.6	26170	76.0	35460	159
	65	43.1	3390	51.5	11070	61.0	21060	71.9	31130	84.4	41100	171
	70	47.6	4990	56.7	14370	67.0	25300	78.8	35940	92.5	46520	183
	75	52.0	6970	61.6	17860	72.6	29470	85.3	40560	100.0	51680	193
	80	56.2	9290	65.3	21420	78.0	33490	91.5	44950	107.2	55570	203
55	55	30.5	1440	36.6	5870	43.5	12820	51.3	20340	60.3	27790	130
	60	35.2	2410	42.1	8490	49.8	16740	58.7	25080	63.9	33280	144
	65	39.7	3740	47.3	11490	55.9	20760	65.8	29760	77.2	39630	156
	70	44.1	5460	52.3	14740	61.7	24780	72.5	34300	85.1	43780	168
	75	48.3	7530	57.1	18120	67.3	28700	79.0	38660	92.6	48700	179
	80	52.4	9320	61.7	21520	72.6	32490	85.1	42820	99.7	53390	189
60	60	32.1	2600	38.3	8680	45.3	16290	53.3	23700	62.5	30940	130
	65	36.5	4030	43.4	11640	51.2	20110	60.2	28120	70.6	36020	142
	70	40.8	5830	48.3	14800	56.8	23910	66.8	32410	78.3	40930	154
	75	44.9	7960	53.0	18030	62.3	27610	73.1	36550	85.6	45650	165
	80	48.8	10370	57.5	21260	67.5	31170	79.1	40510	92.6	50160	175
65	65	33.5	4240	39.7	11570	46.8	19220	55.0	26340	64.5	33390	130
	70	37.6	6090	44.5	14600	52.3	22810	61.4	30410	72.0	38080	142
	75	41.6	8250	49.1	17680	57.7	26300	67.6	34360	79.2	42610	152
	80	45.5	10630	53.5	20730	62.8	29670	73.6	38150	86.1	46970	163
70	70	34.7	6250	41.0	14210	48.2	21570	56.5	28390	66.2	35310	130
	75	38.6	8390	45.4	17130	53.4	24880	62.6	32150	73.2	39670	141
	80	42.3	10720	49.8	20010	58.4	28080	68.4	35790	80.0	43880	151
75	75	35.7	8410	42.1	16440	49.4	23410	57.9	30000	67.7	36850	130
	80	39.4	10660	46.3	19160	54.3	26460	63.5	33490	74.3	40920	140
80	80	36.6	10490	43.0	18230	50.4	24850	59.0	31280	69.1	38120	130

TABLE 55.--CURRENT AND PROJECTED CORD(C5) AND BOARD FOOT INT. 1/4(BF) VOLUME AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX 50		60		70		80		90		PROJECTED BASAL AREA
YEARS		CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	SQ. FT.
140 SQ. FT. INITIAL BASAL AREA												
20	20			4.9	0	14.8	20	21.5	90	27.5	280	140
	25			11.1	10	25.7	90	35.5	320	44.6	870	175
	30			17.6	50	36.5	240	49.3	800	61.3	2020	203
	35			24.8	120	47.1	550	62.3	1650	76.9	3890	226
	40			32.8	270	57.1	1080	74.4	3010	91.2	6650	245
	45			41.8	530	66.7	1920	85.5	5010	104.1	10440	261
	50			51.4	940	75.8	3190	95.7	7790	115.9	15320	274
25	25	2.1	0	15.8	20	23.4	120	30.0	440	36.7	1180	140
	30	4.8	10	23.6	70	33.9	340	42.9	1120	52.2	2770	169
	35	8.2	20	31.5	180	44.2	780	55.4	2310	67.1	5290	193
	40	13.2	50	39.3	390	53.9	1520	67.1	4150	80.9	8860	213
	45	20.3	120	47.0	740	63.0	2670	77.8	6750	93.5	13510	230
	50	29.2	230	54.7	1310	71.6	4330	87.8	10200	105.1	19180	245
	55	39.9	420	62.2	2170	79.6	6600	96.9	14500	115.7	25720	258
30	30	13.3	10	22.7	90	29.7	440	36.6	1420	44.0	3420	140
	35	18.7	30	30.5	240	39.5	1020	48.4	2960	58.0	6540	164
	40	24.3	70	38.2	520	48.9	1990	59.6	5270	71.2	10800	185
	45	30.4	160	45.6	990	57.7	3460	70.0	8440	83.6	16110	203
	50	37.0	310	52.7	1730	66.0	5530	79.8	12460	95.0	22290	219
	55	43.8	560	59.6	2820	73.8	8260	88.8	17270	105.5	29110	233
	60	50.7	950	66.2	4330	81.1	11660	97.1	22720	115.1	36320	245
35	35	19.8	30	27.6	290	34.6	1250	41.9	3510	49.9	7460	140
	40	25.7	90	35.1	650	43.6	2450	52.5	6250	62.5	12210	161
	45	31.6	200	42.2	1250	52.1	4240	62.6	9880	74.4	17930	179
	50	37.5	400	49.1	2170	60.2	6690	72.1	14320	85 5	24330	196
	55	43.4	710	55.7	3500	67.8	9810	81.0	19430	95.9	31160	210
	60	49.3	1210	62.0	5310	74.9	13560	89.3	25010	105.5	38160	223
	65	55.1	1930	67.9	7630	81.6	17850	96.9	30950	114.4	45130	235
40	40	24.4	110	31.5	770	38.5	2850	46.1	6960	54.7	12980	140
	45	30.1	250	38.4	1500	46.7	4920	55.8	10920	66.1	18860	159
	50	35.7	490	45.1	2600	54.6	7680	65.0	15610	76.9	25270	175
	55	41.3	880	51.4	4170	62.0	11100	73.7	20830	87.1	31930	190
	60	46.7	1470	57.5	6240	69.0	15080	81.9	26370	96.5	38620	203
	65	52.0	2340	63.3	8830	75.6	19490	89.5	32030	105.4	45190	215
	70	57.1	3530	68.8	11900	81.7	24160	96.6	37650	113.6	51520	226
45	45	27.8	290	34.6	1730	41.7	5450	49.6	11510	58.6	18990	140
	50	33.2	570	41.0	3000	49.3	8450	58.5	16290	69.1	25250	157
	55	38.5	1040	47.2	4780	56.5	12050	67.0	21470	79.0	31650	172
	60	43.7	1750	53.1	7070	63.3	16140	75.0	26850	88.3	38010	185
	65	48.7	2750	58.7	9860	69.8	20530	82.5	32260	97.0	44190	197
	70	53.5	4110	64.0	13080	75.9	25030	89.5	37560	105.2	50130	209
	75	58.1	5850	69.1	16630	81.7	29650	96.1	42680	112.8	55770	219
50	50	30.4	660	37.1	3340	44.4	8940	52.6	16410	62.0	24510	140
	55	35.5	1200	43.1	5280	51.4	12620	60.8	21460	71.6	30610	155
	60	40.5	2010	48.8	7750	58.1	16710	68.6	26630	80.7	36640	169
	65	45.3	3150	54.3	10670	64.4	21020	75.9	31760	89.3	42490	181
	70	49.9	4650	59.5	13960	70.4	25390	82.9	36760	97.4	48090	193
	75	54.4	6550	64.5	17490	76.1	29710	89.5	41560	105.0	53430	203
	80	58.6	8810	69.3	21150	81.5	33910	95.7	46120	112.1	58470	213
55	55	32.6	1340	39.3	5670	46.7	12860	55.1	20940	64.8	29090	140
	60	37.4	2250	44.8	8250	53.2	16860	62.7	25870	73.7	34800	154
	65	42.0	3510	50.2	11230	59.4	21010	69.9	30730	82.1	40350	166
	70	46.5	5150	55.3	14520	65.3	25180	76.9	35460	90.1	45680	178
	75	50.8	7160	60.2	17980	70.9	29270	83.3	39990	97.6	50760	189
	80	55.0	9510	64.8	21500	76.2	33210	89.4	44300	104.8	55580	199
60	60	34.4	2460	41.1	8560	48.6	16650	57.3	24750	67.2	32700	140
	65	38.9	3820	46.3	11550	54.7	20630	64.3	29360	75.5	37970	153
	70	43.2	5560	51.3	14780	60.4	24590	71.0	33840	83.3	43060	164
	75	47.4	7660	56.1	18120	66.0	28450	77.4	38140	90.8	47930	175
	80	51.5	10050	60.6	21480	71.2	32170	83.5	42240	97.8	52570	185
65	65	35.9	4070	42.6	11640	50.3	19960	59.1	27780	69.4	35510	140
	70	40.1	5880	47.5	14780	56.0	23710	65.7	32030	77.0	40380	152
	75	44.2	8030	52.2	17990	61.4	27370	72.0	36140	84.4	45060	162
	80	48.2	10430	56.7	21170	66.6	30890	78.0	40060	91.3	49540	173
70	70	37.2	6120	44.0	14560	51.8	22660	60.8	30150	71.2	37720	140
	75	41.2	8270	48.6	17620	57.1	26120	67.0	34070	78.4	42230	151
	80	45.1	10650	53.0	20650	62.2	29470	72.9	37840	85.3	46560	161
75	75	38.4	8400	45.2	17090	53.1	24790	62.2	32010	72.9	39480	140
	80	42.1	10720	49.5	19960	58.1	27980	68.0	35640	79.6	43680	150
80	80	39.4	10660	46.3	19160	54.2	26460	63.5	33480	74.3	40910	140

TABLE 56.--CURRENT AND PROJECTED CORD(CS) AND BOARD FOOT INT. 1/4(BF) VOLUME AND TOTAL BASAL AREA PER ACRE FOR NATURAL STANDS OF LONGLEAF PINE

INITIAL AGE	FINAL AGE	SITE INDEX 50		60		70		80		90		PROJECTED BASAL AREA
YEARS		CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	CDS.	FBM.	SQ. FT.
		150 SQ. FT. INITIAL BASAL AREA										
20	20			2.1	0	14.7	20	22.4	80	29.1	250	150
	25			7.2	10	25.5	80	36.7	290	46.6	790	185
	30			12.9	40	36.4	220	50.7	720	63.6	1830	213
	35			19.6	110	47.0	500	63.9	1500	79.4	3540	235
	40			28.0	250	57.2	980	76.0	2740	93.8	6110	253
	45			37.9	480	67.0	1750	87.2	4600	106.8	9670	269
	50			48.6	860	76.4	2920	97.5	7200	118.6	14310	281
25	25			15.4	20	24.4	110	31.7	400	39.1	1090	150
	30			23.1	80	35.1	310	45.0	1020	54.9	2540	179
	35			30.8	160	45.4	710	57.6	2100	70.0	4860	202
	40	3.7	50	38.6	350	55.2	1380	69.4	3790	84.0	8190	222
	45	12.0	110	46.5	670	64.4	2430	80.3	6210	96.8	12590	239
	50	22.9	210	54.5	1190	73.1	3960	90.2	9450	108.4	18040	253
	55	34.9	380	62.5	1980	81.3	6080	99.4	13560	119.0	24430	266
30	30	11.7	10	23.3	80	31.3	410	38.9	1310	46.9	3200	150
	35	16.7	30	31.2	220	41.3	930	50.9	2720	61.2	6110	174
	40	22.2	60	38.9	470	50.8	1820	62.3	4870	74.7	10130	195
	45	28.4	140	46.4	900	59.8	3170	72.9	7830	87.2	15220	213
	50	35.4	280	53.7	1570	68.2	5090	82.7	11660	98.6	21250	228
	55	42.9	510	60.8	2570	76.0	7650	91.8	16300	109.2	28000	242
	60	50.5	870	67.6	3980	83.4	10890	100.1	21650	118.8	35240	253
35	35	19.8	30	29.0	270	36.7	1150	44.6	3290	53.2	7110	150
	40	25.6	80	36.5	590	45.8	2260	55.5	5850	65.1	11680	171
	45	31.6	180	43.8	1140	54.5	3910	65.8	9300	78.2	17250	189
	50	37.7	360	50.8	1980	62.7	6200	75.4	13580	89.5	23590	205
	55	43.9	650	57.5	3210	70.4	9160	84.3	18580	99.9	30440	220
	60	50.1	1100	63.9	4890	77.6	12780	92.6	24130	109.6	37550	232
	65	55.2	1760	69.9	7080	84.3	16980	100.3	30030	118.4	44690	243
40	40	25.2	100	33.3	710	41.0	2660	49.2	6650	58.4	12680	150
	45	31.0	220	40.3	1380	49.4	4600	59.1	10460	70.1	18510	169
	50	36.8	440	47.1	2390	57.3	7220	68.5	15050	81.1	24940	185
	55	42.5	800	53.6	3840	64.8	10500	77.3	20240	91.3	31700	200
	60	48.1	1340	59.7	5790	71.9	14380	85.4	25810	100.9	38550	213
	65	53.6	2140	65.6	8250	78.5	18750	93.1	31580	109.7	45320	225
	70	58.8	3240	71.1	11220	84.7	23450	100.2	37360	118.0	51860	235
45	45	29.1	260	36.7	1600	44.5	5180	53.0	11240	62.7	19010	150
	50	34.6	530	43.3	2790	52.2	8050	62.1	15980	73.3	25360	167
	55	40.1	950	49.5	4450	59.5	11570	70.7	21200	83.4	31920	182
	60	45.4	1600	55.5	6620	66.4	15610	78.7	26680	92.8	38460	195
	65	50.5	2520	61.2	9310	73.0	20020	86.3	32240	101.6	44860	207
	70	55.5	3790	66.6	12460	79.1	24650	93.4	37720	109.8	51000	218
	75	60.2	5430	71.8	15990	84.9	29340	100.0	43020	117.4	56840	228
50	50	32.1	610	39.5	3140	47.4	8670	56.2	16390	66.3	25040	150
	55	37.4	1100	45.6	4980	54.5	12320	64.5	21540	76.0	31330	165
	60	42.5	1850	51.4	7350	61.3	16410	72.5	26840	85.3	37560	179
	65	47.4	2910	57.0	10200	67.7	20780	79.9	32140	94.0	43610	191
	70	52.1	4320	62.3	13460	73.8	25270	86.9	37330	102.1	49410	202
	75	56.7	6120	67.3	17010	79.5	29740	93.5	42310	109.8	54920	213
	80	61.0	8310	72.1	20740	84.9	34110	99.7	47060	116.9	60130	222
55	55	34.5	1250	41.8	5420	49.8	12740	58.9	21340	69.3	30170	150
	60	39.5	2090	47.5	7930	56.4	16810	66.6	26430	78.3	36090	164
	65	44.2	3270	52.9	10880	62.7	21060	74.0	31480	86.9	41840	176
	70	48.8	4820	58.1	14170	68.7	25370	80.9	36390	95.0	47350	188
	75	53.2	6760	63.1	17690	74.4	29620	87.4	41090	102.6	52600	198
	80	57.4	9050	67.8	21310	79.8	33730	93.6	45570	109.7	57560	208
60	60	36.6	2310	43.8	8350	51.9	16940	61.2	25610	71.9	34270	150
	65	41.2	3590	49.1	11340	58.1	20950	68.4	30400	80.3	39750	163
	70	45.6	5260	54.2	14620	64.0	25060	75.2	35060	88.3	45010	174
	75	49.9	7300	59.1	18050	69.6	29090	81.7	39530	95.8	50030	185
	80	54.0	9670	63.7	21520	74.9	32970	87.9	43790	102.9	54810	195
65	65	38.3	3280	45.5	11590	53.8	20510	63.3	29060	74.2	37490	150
	70	42.6	5630	50.5	14200	59.5	24430	70.0	33490	82.0	42530	162
	75	46.8	7740	55.3	18120	65.0	29250	76.3	37750	89.5	47360	173
	80	50.8	10140	59.8	21440	70.3	31930	82.4	41820	96.5	51970	183
70	70	39.7	5920	47.0	14760	55.4	23580	65.0	31780	76.2	40010	150
	75	43.8	8070	51.7	17350	60.8	27210	71.3	35860	83.5	44670	161
	80	47.7	10470	56.2	21110	66.0	30700	77.3	39760	90.5	49130	171
75	75	41.0	8280	48.3	17590	56.8	26030	66.6	33920	78.0	42020	150
	80	44.8	10660	52.7	20600	61.9	29360	72.5	37680	84.9	46340	160
80	80	42.1	10720	49.5	19950	58.0	27960	68.0	35610	79.5	43640	150

Metric Conversion Factors

1 inch = 2.54 cm

1 foot = 0.3048 m

1 ft^2 = 0.0929 m^2

1 ft^3 = 0.02832 m^3

1 acre = 0.4047 ha

1 ft^2/acre = 0.2296 m^2/ha

1 ft^3/acre = 0.6997 m^3/ha

1 lb/ft^3/acre = 39.5774 kg/m^3/ha

GPO U.S. 1980 671 476

Farrar, Robert M., Jr.
1979. Growth and yield predictions for thinned stands of even-aged natural longleaf pine. U.S. Dep. Agric. For. Serv. Res. Pap. SO-156, 78 p. South. For. Exp. Stn. New Orleans, La.

Presents a system of equations and resulting tables that can predict current and future stand volumes for thinned natural longleaf pine—total stand volume in cubic feet and merchantable stand volume in cubic feet, cords, and board feet.

Additional keywords: *Pinus palustris,* production.

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Cottonwood Borer (*Plectrodera Scalator*) — A Guide to its Biology, Damage, and Control

J.D. SOLOMON

Southern
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SUMMARY

Studies of the cottonwood borer have now revealed a 1-year life cycle in roots of young cottonwoods. Before this discovery, only a 2-year life cycle had been known. The shorter life cycle helps explain rapid increase of borers in nurseries that have had serious damage. Cottonwood borer larvae weaken, sever, and girdle infested plants at the root collar. Feeding adults injure bark and break terminals. Chlorpyrifos and diazinon directed toward eggs and early larval stage at the root collar, significantly reduced the number of borers. Three weekly applications of carbaryl, chlorpyrifos, or diazinon should control adult beetles. Management practices such as locating the nursery away from infested trees, planting uninfested cuttings, and removing and destroying infested rootstocks, help minimize nursery damage. Natural enemies provide some control.

1980

Cottonwood Borer (*Plectrodera Scalator*) — A Guide to its Biology, Damage, and Control

J. D. SOLOMON

INTRODUCTION

Cottonwood borer, *Plectrodera scalator* (Fab.), attacks poplars and willows, mostly in the eastern United States. Cottonwood borer invades the root collar and main roots of host trees regardless of their age or size. Young trees may be so structurally weakened by tunnels and mines or so badly girdled that breakage occurs. Greatest damage has been observed in nurseries and young natural stands growing on sandy soils.

Few papers have been published on the cottonwood borer. Milliken (1916) studied its biology in Kansas and indicated a 2-year life cycle. Morris (1963) reported his observations of the borer in young Mississippi trees. This paper presents results of a series of studies that I conducted on the biology, damage-effect, and control of cottonwood borer.

BIOLOGY

Stages of Development

The adult cottonwood borer is a long-horn beetle with a strong, sharp, lateral spine on each side of the pronotum (fig. 1). The beetle is very large, robust, and heavy-bodied. It ranges from 1 to 1-1/2 inches (25–38 mm) long and 3/8 to 1/2 inch (10–13 mm) wide. The head, thorax, and elytra are black overlaid with patches of pure white, fine hairs that surround black, hairless areas. The black and white pattern on the elytra forms irregular cross-stripes. The antennae are about the length of the body in the female and slightly longer in the male.

The egg is white to yellowish, elliptical in shape and about 1/8 inch (3 mm) long (fig. 2). The chorion is tough and leathery.

The larva is legless, elongate, and moderately robust (fig. 3). It is yellowish-white except for dark-brown mandibles and amber spiracles. Since the larva is legless, it depends on well-developed ampullae for locomotion, so its range is limited to its mines and galleries. Larvae are 3/16 inch (5 mm) long when newly hatched and reach 1-1/4 to 1-1/2 inches (32–38 mm) at maturity.

Newly transformed pupae are white and delicate. But the eyes, mandibles, and appendages darken as pupae mature (fig. 4).

Distribution

Morris (1963) reports the distribution of the cottonwood borer as the southeastern United States. Baker (1972) gives its range as simply the southern states. Its distribution appears, however, to correspond closely with the range of eastern cottonwood (*Populus deltoides*), generally the eastern United States. I have observed cottonwood borer populations in Arkansas, Louisiana, Mississippi, and Tennessee. The borer has been found as far west as Texas (Finn, Mastro, and Payne 1972), New

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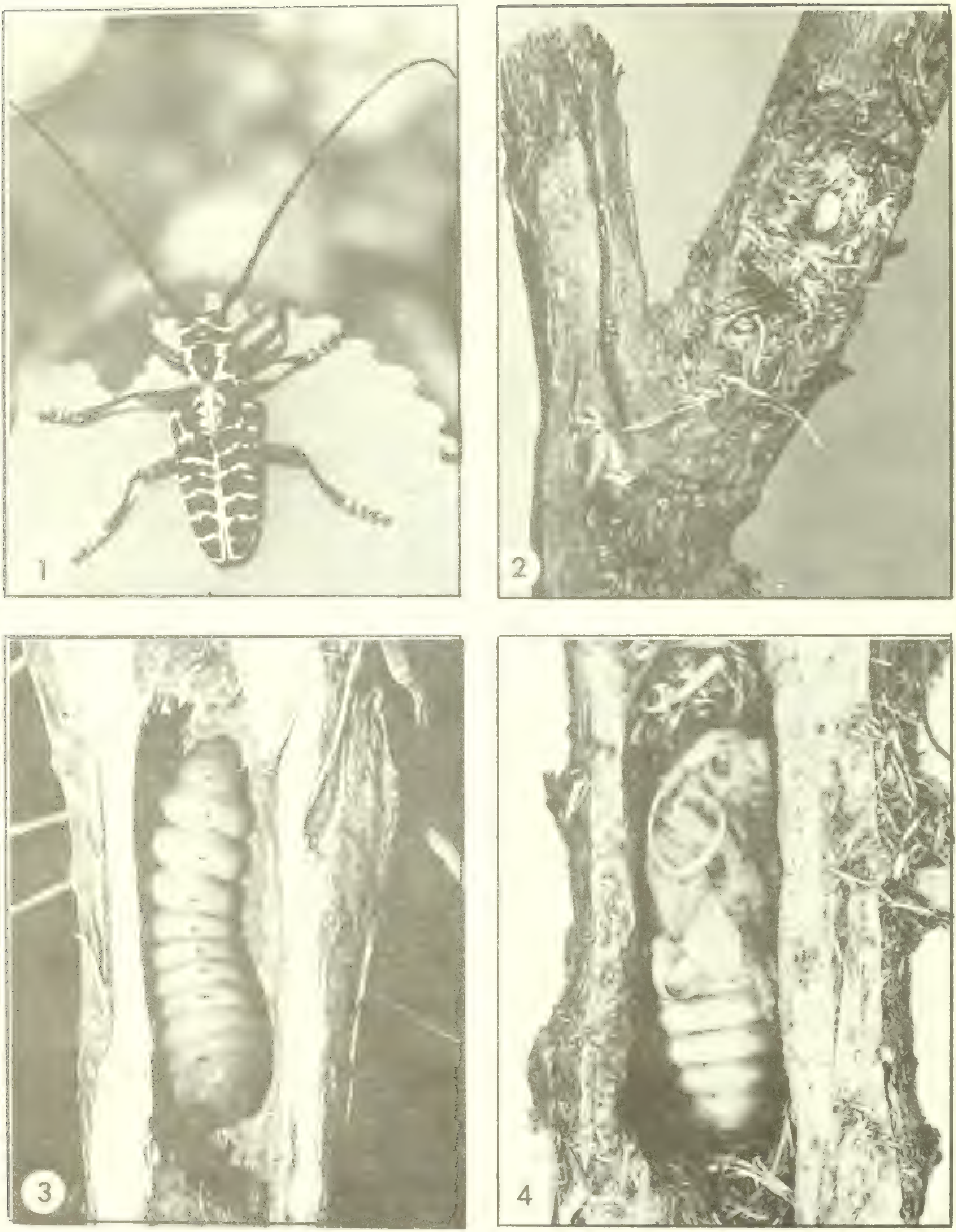


Figs. 1-4.—Stages of *P. scalator*. (1) Adult beetle. (2) Shredded bark and wood of egg niche pulled back to expose egg. (3) Full-grown larva. (4) Pupa in pupation chamber.

Mexico and Montana (Furniss and Carolin 1977) and as far north as Michigan (Gosling and Gosling 1976), Ohio (Knull 1946), and North Dakota (Stein and Tagestad 1976). But highest populations and greatest damage occur in the southern and central parts of its range.

Hosts

Cottonwood borer's hosts are generally given as poplar, cottonwood, and willow, though host species are often not identified. Milliken (1916) recorded finding cottonwood borer in eastern cottonwood (*P. deltoides*) and white willow (*Salix alba*). I have found it in *P. deltoides* and black willow (*S. nigra*) in both planted and natural stands. In the southern states, *P. deltoides* receives the greatest cottonwood borer damage and is its major host.

Life and Seasonal Histories

In Mississippi, adult emergence begins during the latter half of May, peaks during early June, and ceases in late June or early July. Beetles appear earliest from young, small-diameter roots. In 1978, sixty-one adults reared in roots of 1-year-old plants appeared from May 26 through June 14. Emergence from roots of 9-year-old trees occurred as late as June 25. Milliken (1916) reported that emergence in Kansas began in late June and continued for about 50 days.

After feeding on petioles, greenwood twigs, and tender bark, the female begins egg-laying. To lay eggs, the female uses her jaws, head, and legs to loosen the soil and dig a pit 1/4 to 3/4 inch (6–19 mm) deep in the soil next to the tree. She chews a niche through the bark at the root collar, then forces her strong ovipositor into the niche of shredded bark and wood and lays a single egg. As the female exits from the pit, she moves her abdomen back and forth, partially filling the soil pit.

Eight reared females, paired with males and caged over 1-year-old cottonwood trees, laid an average of 11 eggs (range 6-16), but would probably have laid more under natural conditions. Milliken (1916) dissected females and found as many as 24 eggs in a single female.

Adults are long-lived, sometimes surviving for 1 month or more. In Mississippi, beetles are most prevalent during June and July, but few are present during August. In Kansas, Milliken (1916) observed females laying eggs as late as August 28 and reported finding beetles as late as September.

The incubation period for eggs during June in Mississippi ranged from 16 to 18 days and averaged 17 (n=22). Milliken (1916) reported an incubation period of 13 days during July in Kansas.

Young larvae mine downward into the inner bark and soon begin etching the xylem. In 1- to 2-year-old plants, galleries extend downward and are limited almost entirely to the taproot. In young plants infested with two or more larvae, galleries occasionally extend upward slightly above ground level. In larger trees, galleries are shallow, usually penetrating no deeper than 1 inch (25 mm) into the wood or xylem. In some instances the grub hollows out an area 2–3 inches (51–76 mm) in diameter and roughly oval in shape. This pattern is quite common where grubs have tunneled in large roots. Larvae feeding in small lateral roots often make narrow galleries 4–8 inches (10–20 cm) long.

Portions of mines and galleries are packed with excelsior-like frass, and openings in the bark are kept plugged tightly with frass. Many larvae wall off their galleries with this tightly packed frass. Two or more may survive in close proximity then, even though larvae are cannibalistic and galleries often intersect.

During spring of the final year of the life cycle, the mature larva prepares a pupation chamber in its gallery. Pupation occurs from late April until early June and lasts for 21–24 days. The new adult chews an exit hole through the packed frass or the side of the pupal chamber and digs its way to the soil surface. Exit holes 3/8 to 1/2 inch (10–13 mm) diameter can often be seen in bark at the root collar or adjacent soil surface.

In early May 1978, I lifted twenty-five 1-year-old infested plants near Vicksburg, Mississippi, and transplanted them at Stoneville. These plants were started from uninfested cuttings in the Vicksburg nursery during spring 1977 and became infested during summer 1977. Thirty-six adults emerged from the caged plants during summer 1978, thus completing a life cycle in 1 year. Also, examination of 100 2-year-old plants in April 1979 revealed larvae of two distinct sizes (84 large and 16 small). So, this evidence suggests both a 1- and 2-year life cycle. Only a 2-

year life cycle for the cottonwood borer was previously known (Milliken 1916, Morris 1963). Most of that work, however, dealt with borers in older trees, while current studies were made in plants 1-year old and older.

DAMAGE

Nursery Damage by Larvae

Larvae may hollow, partially sever, or girdle young plants at, or slightly below, the root collar and so cause structural weakening and loss of vigor (fig. 5). A single grub may seriously weaken a 1-year-old plant, but breakage (fig. 6) is more likely when there is multiple infestation. As many as five larvae have been found in the taproot of a single 1-year-old plant. Sprouts of infested plants are weakened as indicated by shrivelling and drying of the terminal, twigs, and bark. So, survival of cuttings made from infested plants is undoubtedly reduced.

Although many nurseries become infested by the cottonwood borer, only a few have been heavily damaged. I surveyed 100 randomly selected plants per age group in a heavily infested Vicksburg nursery in 1977–1978. In 1977, 26 percent of the 2-year-old plants, but only 7 percent of the 1-year-old plants were infested. In 1978, the infestation in a 1-year-old planting averaged 27 percent.

Nurserymen producing long-rooted cuttings should cull infested plants. As rooted cuttings are lifted, soil can be shaken loose and roots exposed. Infested roots are generally swollen and galled with breaks and openings in the bark (fig. 7). These breaks frequently expose borer frass. Uninfested roots are comparatively uniform in shape and smooth in appearance (fig. 8).

Nursery Damage by Adults

Previous reports of cottonwood borer damage have been only of tunneling injury by larvae. In 1976–77, however, adult beetles became so numerous in the Vicksburg nursery that serious damage resulted from their feeding and egg-laying. Over 75 percent of the sprouts in a 2nd-year planting had bark injuries from adult feeding (fig. 9). These injuries were so severe that numerous terminals broke 3-24 inches (7.6-61.2 cm) from the tip (fig. 10). Also, over 60 percent of the leaf petioles were severed in some parts of the nursery, causing a ragged, defoliated appearance (fig. 11). The extensive bark injury and broken terminals caused excessive branching, forking, and crooked sprouts, so the quality of sprouts for making vegetative cuttings deteriorated. Also, numerous egg-laying niches chewed into stems (fig. 12) at the groundline made plants vulnerable to breakage by wind and by cultivation equipment.

Plantation Damage

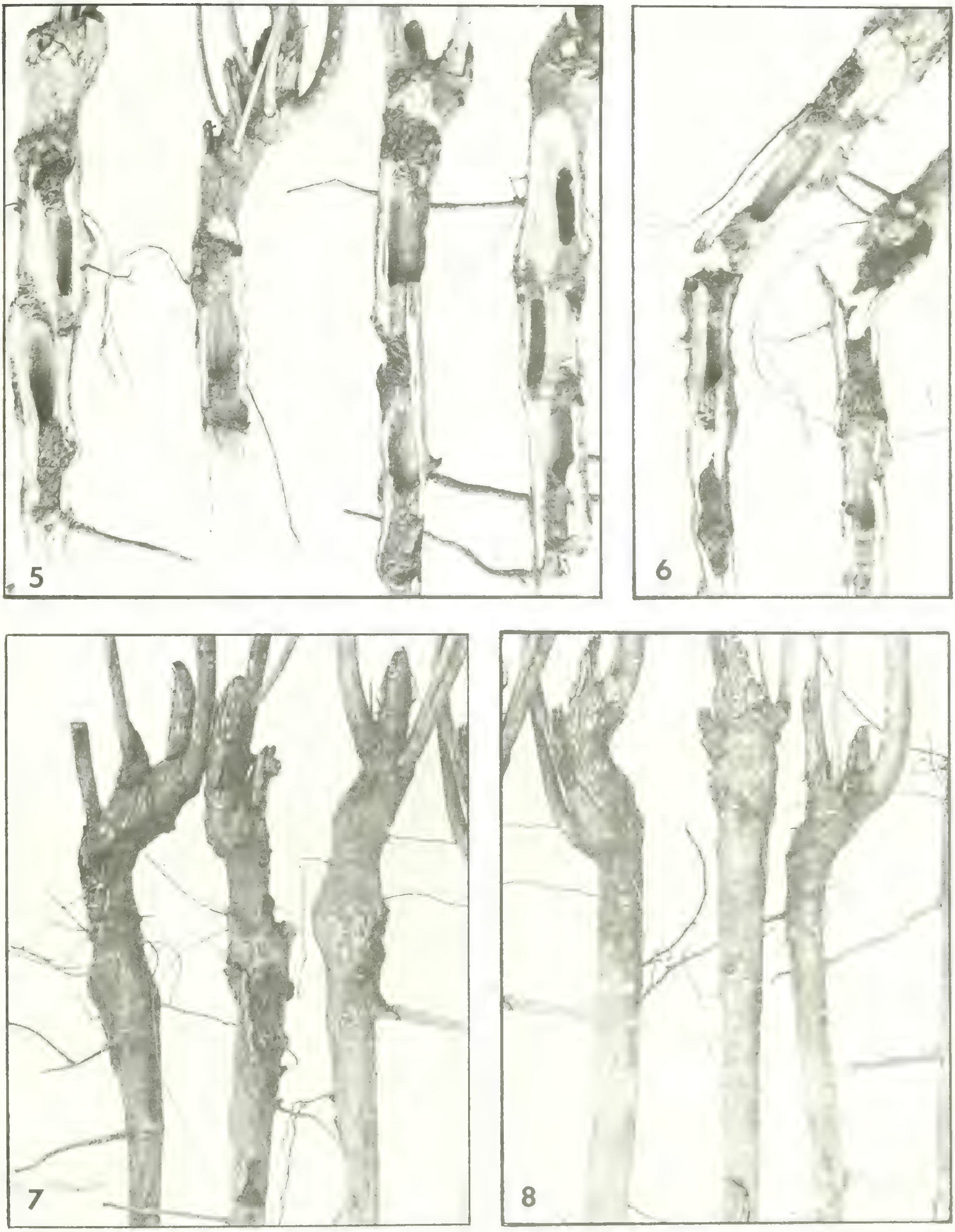
Although trees in plantations are sometimes moderately to heavily infested, the actual impact of cottonwood borers is unknown. Young trees in their first or second growing season are occasionally girdled or severed at the groundline; older trees rarely die. But, how borer infestation affects tree vigor and growth in older trees needs to be studied.

I studied the degree of infestation in young plantations on Archer Island, Arkansas, by excavating and examining ten 2-1/2-year-old trees and ten 3-1/2-year-old trees. Stumps in the older group supported 46 grubs for an average of 4.6 grubs per stump; three stumps contained seven grubs each (fig. 13). Though the younger trees were less infested, eight of ten stumps were infested with from one to three grubs.

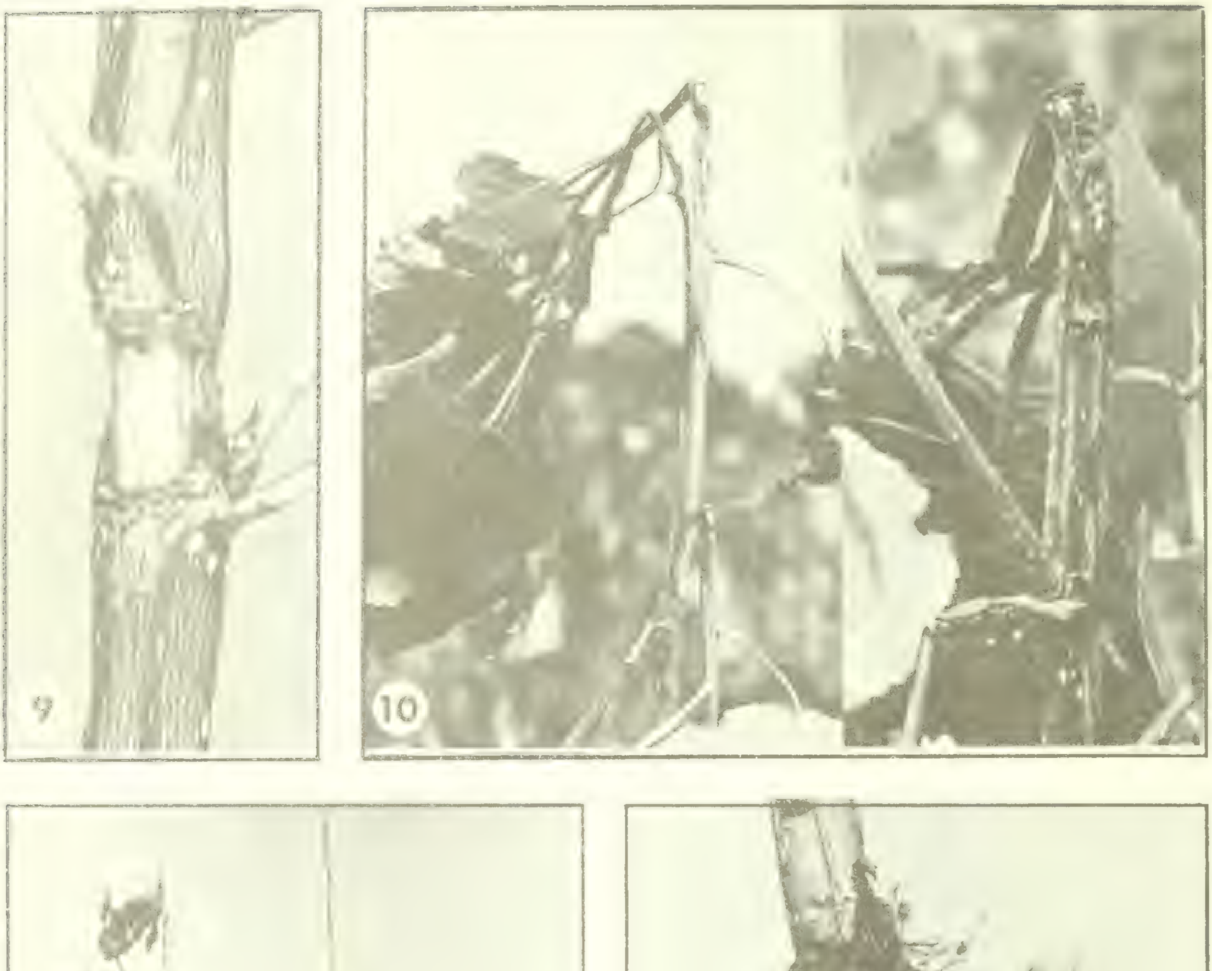
Milliken (1916) examined the roots of 10 trees 4–8 inches (10.2–20.4 cm) in diameter at Garden City, Kansas, and found all 10 trees infested with 4–14 grubs for an average of 8.2 grubs per tree. He stated that such an infestation could reduce growth and make the trees liable to wind damage.

Natural Stand Damage

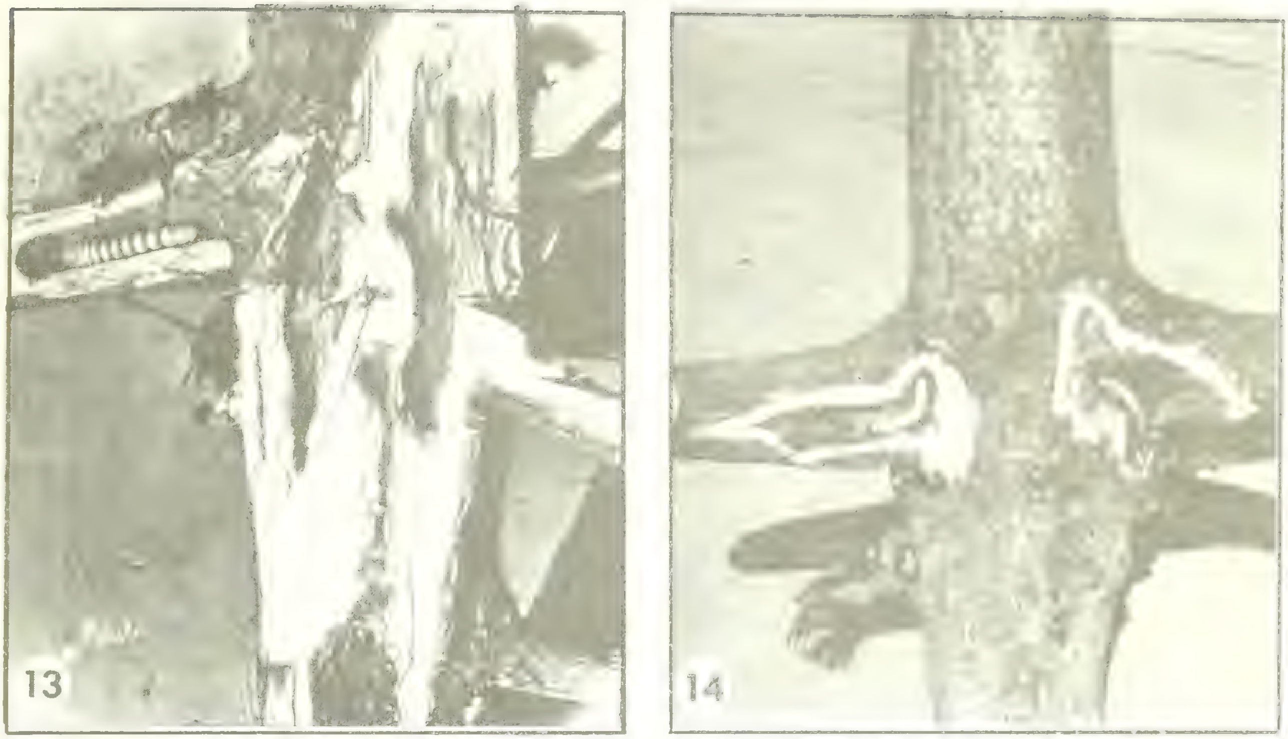
I examined three young natural stands along the Mississippi River near Meyersville, Mississippi, for borers in September 1972. One-hundred trees 1–4 years old were selected at random from each stand and examined. From 6 to 14 percent of the trees were infested with 1–5 grubs per tree (fig. 14). A few small trees were broken at the girdle.



Figs. 5-8.—Larval damage to 2nd-year cottonwood rootstocks. (5) Rootstocks dissected to expose tunneling damage. (6) Stem severed causing breakage. (7) Infested roots are swollen and galled with openings and frass exposed. (8) Uninfested roots are smooth and uniform in shape.



Figs. 9-12.—Injuries from adult feeding and egg-laying. (9) Bark injury from feeding. (10) Left, terminal broken at feeding site; right, close-up of terminal feeding causing breakage. (11) Petioles severed causing defoliated appearance. (12) Chewing injury associated with egg niches and egg-laying.



Figs. 13-14.—Borer damage in older trees. (13) Bark removed from stump to expose 7 longitudinal galleries. (14) Bark removed exposing 2 oval or cave-type galleries.

CONTROL

Chemical Control

I evaluated several chemical controls for the cottonwood borer in a 6-acre (2.4-ha) cottonwood nursery near Vicksburg, Mississippi, during 1977 and 1978.

Chemical Control (Aerial).—Inspection of the nursery in June 1977 revealed that a very high population of beetles was severely damaging the shoots. Prespray counts of beetles were made of ten 300-ft (91-m) rows randomly chosen in both 1- and 2-year-old plantings. Beetle counts ranged from 17 to 56 per row in the 2-year-old planting and 1-6 in the 1-year-old planting. Diazinon AG-500 was diluted in water and applied aerially at the rate of 0.75 lb active ingredient (AI) per acre (0.85 kg AI/ha). Total volume of diluted spray was 5 gal per acre (47 l/ha).

Post-spray counts made 48 hours after spraying revealed excellent control in the 1-year-old planting and moderately good control in the 2-year-old planting (table 1). Most plants in the 1-year-old planting were 2–3 ft (0.6–0.9 m) high at time of spraying, while most in the 2-year-old planting were 4–6 ft (1.2–1.8 m) tall. The better control achieved in the younger planting was probably caused by better spray penetration among the smaller plants.

Table 1.—*Effects on cottonwood borer adults of Diazinon AG-500 applied aerially at the rate of 0.75 lb AI/acre (0.85 kg AI/ha) in a cottonwood nursery at Vicksburg, Miss., in 1977*

		Mean (±SE) no. beetles/300-ft (91-m) row			
Age of plants	No. rows in sample	Prespray counts Alive	Postspray counts Alive	Postspray counts Dead	Mean percent control
1st yr	10	3.8±0.8	0.2±0.1	7.5±1.8	97.1±1.9
2nd yr	10	34.2±3.8	7.1±0.9	27.5±2.5	79.9±0.8

Chemical Control (Backpack Mistblower).—In 1978, adults began emerging about May 26.

Table 2.—*Effects on cottonwood borer adults of insecticides applied with backpack mistblower in a cottonwood nursery at Vicksburg, Miss., in 1978*

Insecticide	Rate lbs AI/acre (kg AI/ha)	$\overline{X}$ no. beetles/220-ft (67-m) row								
		3 days			6 days			10 days		
		Alive	Dead	% Kill	Alive	Dead	% Kill	Alive	Dead	% Kill
Carbaryl (Sevin 80S)	3.00 (3.40)	1.1	11.2	91.1	1.3	3.2	71.1	2.5	0.8	24.2
Carbaryl (Sevin SL-2)	2.00 (2.27)	0.9	12.5	93.1	0.4	3.0	88.2	2.5	2.3	47.9
Chlorpyrifos (Dursban M)	0.50 (0.57)	1.3	3.8	74.5	3.6	1.9	34.5	....	....	....
Chlorpyrifos (Dursban M)	0.75 (0.85)	0.1	3.1	96.9	1.9	2.1	52.5	....	....	....

Table 3.—*Effects on cottonwood borer adults of insecticides applied with hydraulic sprayer in a cottonwood nursery at Vicksburg, Miss, in 1978*

Insecticide	Rate lbs AI/acre (kg AI/ha)	$\overline{X}$ no. beetles/220-ft (67-m) row								
		1 day			3 days			8 days		
		Alive	Dead	% Kill	Alive	Dead	% Kill	Alive	Dead	% Kill
Carbaryl (Sevin 80S)	2.00 (2.27)	0.2	2.5	92.6	0.0	0.2	100.0	0.1	0.5	83.3
Carbaryl (Sevin SL-2)	1.50 (1.70)	0.3	3.1	91.2	0.0	0.7	100.0	0.1	0.9	90.0
Chlorpyrifos (Dursban M)	0.75 (0.85)	0.1	4.8	98.0	0.1	0.8	88.9	0.4	0.8	66.7

By June 2, when tests were made, prespray counts in 1-year-old plantings ranged from 3 to 7 beetles per 220-ft (67-m) row. Plants were 5-6 ft (1.5-1.8 m) tall. Single rates of two formulations of carbaryl and two rates of chlorpyrifos were diluted in water and applied to single blocks one-half to one acre (0.2-0.4 ha) in size. Nine gal diluted spray was applied per acre (85 l/ha) with a backpack mistblower. Postspray counts of live and dead beetles were made in twelve 220-ft (67-m) rows per treatment at 3, 6, and 10 days after spraying.

Both formulations of carbaryl gave good control for 3 days and moderately good kill up to 6 days, but control dropped considerably at 10 days (table 2). After 3 days, chlorpyrifos at 0.75 lb AI/acre (0.85 kg AI/ha) gave excellent control, while the 0.5 lb AI/acre (0.57 kg AI/ha) rate gave only moderately good control. Control by both rates of chlorpyrifos dropped noticeably at 6 days.

Chemical Control (Hydraulic Sprayer).—On June 12, 1978, new adults were still emerging, but the rate was declining. Prespray counts usually found from two to three beetles per 220-ft (67-m) row. Plants were 6-7 ft (1.8-2.1 m) tall. The rates of carbaryl were 2 lbs AI/acre (2.3 kg AI/ha) for Sevin 80S and 1-1/2 lb AI/acre (1.7 kg AI/ha) for Sevin SL-2. Chlorpyrifos was applied at 0.75 lb AI/acre (0.85 kg AI/ha). A hydraulic sprayer, moving at 2 mi/h (3.2 km/h), delivered 48 gal diluted spray per acre (455 l/ha) at 200 lbs/in^2 (14 kg/cm^2). Postspray counts of live and dead beetles were made in twelve 220-ft (67-m) rows per treatment at 1, 3, and 8 days after spraying (table 3).

Both Sevin 80S at 2 lb AI/acre (2.3 kg AI/ha) and Sevin SL-2 at 1-1/2 lb AI/acre (1.7 kg AI/ha) gave very good control at 1 and 3 days, and moderately good control at 8 days. Chlorpyrifos at 0.75 lb AI/acre (0.85 kg AI/ha) gave excellent control at 1 day, moderately good control at 3 days, and fair control at 8 days.

Chemical Control (Tractor-mounted Boom Sprayer).—A 1st-year nursery planting with shoots 2–3 ft (0.6–0.9 m) tall was lightly infested with adult cottonwood borers in 1978. I used a tractor-mounted boom sprayer to apply carbaryl 80S to plants at the rate of 2 lbs AI/acre (2.3 kg AI/ha). Twenty gal diluted spray was applied per acre (190 l/ha.). Counts made 2 days after spraying revealed nine dead beetles and only one living beetle.

Chemical Control (Hand Sprayer).—In 1977, a test for control of cottonwood borer infestation after eggs are laid was conducted in a 1st-year planting. Bases of plants where the eggs had been laid were sprayed at time of egg-hatch and at early larval stage. Chlorpyrifos at rates of 2 tsp and 2 tbsp per gal (2.6 and 7.9 ml/l) and Diazinon AG-500 at 2 tbsp/gal (7.9 ml/l) were applied to "run-off" with a 2-gal (7.6-l) hand sprayer. Three 25-ft (7.6-m) row-sections (plants 1 ft (0.3 m) apart) were treated with each rate of insecticide. An untreated check was also included. Treatments were replicated three times in a randomized-block design.

All three insecticide treatments significantly reduced the number of borers (table 4). Chlorpyrifos at 2 tbsp/gal (7.9 ml/l) gave the highest mean reduction. Timing of treatments directed at the newly hatched larvae is critical. If treatment were delayed, many larvae would already have tunneled beyond reach of insecticides.

Chemical Control (Soil-applied Systemic).—To control foliar and twig insects, the Vicksburg nursery had used carbofuran annually for several years before 1978. Applied at the rate of 4 lbs AI/acre (4.5 kg AI/ha) with a tractor-driven subsoil applicator, carbofuran failed to control cottonwood borers.

Control by Nursery Management

In high-risk areas, select the nursery site carefully. Where feasible, the nursery should be located away from naturally occurring or planted cottonwood. The likelihood of invasion from surrounding infestations would then be reduced. The nursery should certainly be established with uninfested cuttings.

Table 4.—*Effects on cottonwood borer larvae of insecticides applied to bases of 1st-year nursery-grown cottonwood and timed to coincide with egg-hatch and early larval stage at Vicksburg, Miss., in 1977*

Insecticide	Rate per gal (ml/l)	Mean no. living borers/25-ft (7.6-m) row[1]	Percent reduction
Check	....	2.78 a	......
Chlorpyrifos (Dursban M)	2 tbsp (7.9 ml)	0.22 b	92.1
Chlorpyrifos (Dursban M)	2 tsp (2.6 ml)	0.55 b	80.2
Diazinon AG-500	2 tbsp (7.9 ml)	0.67 b	75.9

[1] *Means followed by the same letter are not significantly different at the 0.05 level as judged by Duncan's new multiple range test.*

To have plantings of more than one age is common practice in many nurseries. Rootstocks are usually rogued and new plantings established after 3 years. Cottonwood borer populations often build up in older rootstocks, and many emerging adults fly to adjacent new plantings and lay eggs in the rootstocks. When older plantings are scheduled for removal, nurserymen should collect, pile, and burn rootstocks before May 1 to destroy borers before adult beetles emerge and reinfest the nursery. When old rootstocks are lifted but not destroyed until late summer, many borers can complete development and invade new plantings in the nursery.

Natural Controls

Since most cottonwood borer attacks are at the root collar from which larvae tunnel downward, they are well protected from both predators and parasites. Only one parasite species, *Sarcophaga vericanda* Coq., has been recorded (Hungerford 1915). Woodpeckers capture a few larvae in stems or exposed roots above the groundline.

On sandy sites along rivers, observers have found many cases where sand had been dug away from small plants to depths of 2-6 inches

(5-15 cm); holes had been chewed in the roots, exposing galleries; and the grubs were missing. But no more than 3 percent of the infested roots were exposed at any locality. I never saw predators. But skunks and raccoons are suspect. Their tracks were prevalent in the areas, and the evidence is similar to other digging and feeding activity of these animals.

A few larvae succumb to a fungus disease, *Beauvaria* sp., but incidence has been low. Milliken (1916) also refers to a fungus disease of the cottonwood borer.

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Cottonwood borer can have a life cycle of 1 or 2 years. Cottonwood borer larvae attack plants at the root collar and tunnel into the roots. Feeding adults injure bark and break terminals. Natural enemies, management care, and chemicals can minimize damage.

Additional keywords: Cerambycidae, description, distribution, hosts, nurseries, plantations, natural stands, insecticides, natural controls.

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Thinning Planted Slash Pine on Cutover Flatwood Sites in the West Gulf

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SUMMARY

Eight thinning regimes started at age 17 and an unthinned check were compared for slash pine planted on a productive cutover site in southwest Louisiana. Over 20 years, cubic-foot volume growth increased directly with residual basal area. Growth of the check plots fell below that of the thinning treatments because of high mortality between ages 27 and 37. Diameter increment was related inversely to stand density, and growth of merchantable trees did not exceed 0.28 inch yearly in any treatment. While sawtimber production generally followed the trend of cubic-foot volume, only four thinning treatments produced more standing volume by age 37 than did the check.

ACKNOWLEDGMENTS

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1979

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DONALD P. FEDUCCIA

INTRODUCTION

Large acreages of cutover, flatwoods sites in the West Gulf Coastal Plain have been planted to slash pine (*Pinus elliottii* Engelm. var. *elliottii*). However, information has been limited on growth and yield of thinned stands of this species beyond its natural range. Published thinning studies conducted on similar sites in the region apply mainly to pulpwood production in stands less than 30 years old (Enghardt and Mann 1972, Feduccia 1974, and Feduccia 1977). In this paper, cubic-foot and sawtimber volume production of planted slash pine are compared between stand ages 17 and 37 for several thinning regimes and no thinning.

STUDY DESCRIPTION

This study was begun in a 17-year-old slash pine plantation in southwest Louisiana, on land formerly occupied by longleaf pine (*P. palustris* Mill.). Stands were established by hand planting 1-0 nursery stock at spacings of about 6 by 7 feet (1,037 seedlings per acre). Previously, the land had supported only native grasses.

Initial survival was not documented; however, at age 17 there were 690 trees per acre, indicating adequate stocking. One year before the study began, an average of 72 small trees per acre with fusiform rust stem galls (*Cronartium quercum* (Berk.) Miyabe and Shirai f. sp. *fusiforme*) was removed in a light thinning. Volumes of these trees were added to cut volumes at age 17, mean annual growth, and total yield. Fusiform rust stem infection averaged 20 percent before cutting on the remaining trees at age 17.

Soil was mostly Beauregard silt loam, with small areas of Caddo silt loam interspersed; both have slow internal drainage.

Site indices for plots ranged from 96 to 108 ft (index age 50). Average heights of dominant and codominant trees were determined and guide curves for slash pine in U.S. Department of Agriculture, Forest Service, Miscellaneous Publication 50 (1976) were used to estimate site index.

Eight thinning regimes plus an unthinned check were started at age 17. Residual stocking levels were within ± 3 ft^2 per acre of assigned densities. Identified by the notations at left, the treatments were:

BA 70	Thin to 70 ft^2 of basal area every 5 years.
BA 85	Thin to 85 ft^2 of basal area every 5 years.
BA 100	Thin to 100 ft^2 of basal area every 5 years.
BA 85 (10 years)	Thin to 85 ft^2 every 10 years.
BA 95/55	Thin to 95 ft^2 at age 17, and to 55 ft^2 at age 22 and every 5 years thereafter. Reduction of stocking in two steps was undertaken to avoid a heavy release that would leave trees vulnerable to wind and ice damage.

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BA 95/115	Thin to 95 ft^2 at age 17, and to 115 ft^2 at age 22 and every 5 years thereafter. The first thinning removed badly diseased trees.
Increasing BA	Thin to 85 ft^2 at age 17, increasing residual density by 5 ft^2 every 5 years to 120 ft^2 at 52 years.
D+	The sum of D + X, expressed in feet, was for an average spacing between trees after cutting. D was the average d.b.h. of the stand, and X was equal to 4 plus the expected 5-year diameter growth in inches. Specified residual density progressively changed with each thinning: 67, 78, 90, and 95 ft^2 per acre at ages 17, 22, 27, and 32.
Check	Unthinned. Basal area increased from 114 ft^2 per acre at 17 years to 167 ft^2 at age 37.

Thinning generally was from below, with cutting restricted to merchantable trees (3.6 inches d.b.h. and larger). The first thinning was intended as an improvement cut. Subsequent thinnings removed the slowest growing trees as well as diseased and/or intermediate or codominant trees. Prospective crop trees were favored in all treatments.

Each treatment had four replications, except BA 95/115. One plot of this treatment was abandoned at age 30 because of an infestation of *Ips* (spp.) engraver beetles after a lightning strike. Beginning at age 32, growth and yield data for this treatment were the average of three replications.

Measurement plots were 0.25 acre and surrounded by an isolation strip 0.5 chain wide. The five or six rows of the isolation strips were thinned to the same basal area level as were the measurement plots.

Measurements were taken when the plots were established and at 5-year intervals thereafter. Diameters (d.b.h.) of merchantable trees were measured before thinning. Sample tree volumes were determined by the height accumulation method (Lohrey and Dell 1969). The number of trees sampled for volume was in proportion to the diameter distribution on each plot. Total height and height to succeeding 2-inch taper steps to a top diameter of 4 inches (outside bark) were determined with a Spiegel-Relaskop[1] on volume sample trees. Plot volumes were computed by multiplying total basal area by the volume/basal area ratio for volume sample trees.

To calculate cubic-foot volume of peeled wood (inside bark), bark thickness was measured on 100 felled trees distributed among plots when stands were thinned. Data were taken at breast height, midpoint of merchantable stem, and 4-inch top (d.o.b.). Ratios of d.i.b./d.o.b. averaged 0.87 at ages 17 and 22, 0.88 at ages 27 and 32, and 0.89 at age 37. Volumes and volume growth were estimated in cubic feet of peeled wood and included trees 3.6 inches d.b.h. and larger to a 4-inch top, outside bark (merchantable trees). For conversion to standard rough cords, volumes should be divided by 76.3 ft^3.

The International 1/4-inch rule was used to compute volumes for saw log size trees (9.6 inches d.b.h. and larger to a top diameter of 8 inches, d.o.b.). Multiply the International data by 0.76 to approximate values for the Doyle log rule.

Stocking was similar at the outset for individual treatments (table 1). Cubic-foot volumes, inside bark, differed by only 257 ft and ranged from 1,685 to 1,942 ft^3 per acre. Estimated site index, number of merchantable trees, basal area, and d.b.h. varied less than 5 percent.

Mortality was determined; however, only net volumes were compared. On thinned plots, losses from suppression were negligible, and mortality from other causes was unrelated to treatment. Losses were greatest on unthinned plots and were caused by suppression, root rot (*Heterobasidion annosum* (Fr.) Breaf.), bark beetles, and fusiform rust. Most mortality occurred between ages 27 and 37. Special precautions were taken to control bark beetle infestations and protect stump surfaces from infection by *H. annosum*.

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[1] Mention of trade name is for information only and does not imply endorsement by the U. S. Department of Agriculture.

Table 1.—*Merchantable stand and stocking data before cutting at age 17*

Thinning treatment	Site index (age 50)	Trees	Basal area	D.b.h.	Volume (i.b.)
	Feet	*Number*	*Ft*^{2}	*Inches*	*Ft*^{3}
BA 95/55	100	645	120	6.0	1,867
BA 70	100	619	112	6.0	1,746
BA 85	102	622	118	6.0	1,739
BA 85 (10-year)	100	650	119	6.0	1,685
Increasing BA	100	640	120	6.0	1,828
BA 100	103	596	116	6.2	1,942
BA 95/115	102	648	122	6.0	1,923
D+	100	639	117	6.0	1,717
Check	100	625	114	5.9	1,707

RESULTS

Periodic Annual Volume Growth

Net periodic annual volume growth in the first 5 years increased sharply with higher residual basal areas at age 17 (table 2). The D+ plots, with the least residual density (67 ft^2 per acre), had the lowest growth; check plots, with 114 ft^2 of basal area per acre, had the highest volume growth. Between stocking levels of 70 and 100 ft^2, annual growth increased about 22 ft^3 per acre for each additional 15 ft of residual density.

Residual basal areas after thinning at age 22 differed from those at the start of the first period, except for the three constant density treatments (BA 70, 85, and 100). Volume growth was not as closely related to density in the second 5-year period as it had been in the first. Plots thinned to 55 ft^2 at age 22 (BA 95/55) had least growth; plots of the BA 85 (10-year) cycle treatment (116 ft^2 at age 22) had best growth. The check ranked fifth, although these plots had the highest basal area per acre (147 ft^2) at age 22.

Cubic-foot volume growth during the third 5-year period decreased in all treatments compared to the preceding growth period, except for the D+ thinning. The average annual decrease was 63 ft^3; greatest reductions were on the BA 85 (10-year) and Increasing BA plots. Most growth occurred on the D+ plots, which averaged 90 ft^2 of basal area at the beginning of the period. Growth of check plots was equivalent to that on the most heavily thinned plots (BA 95/55 and BA 70). The check averaged 170 ft^2 of basal area per acre at age 27. As a result of this high density, mortality more than doubled in comparison to the preceding 10 years. Major cause of volume losses was suppression, followed closely by root rot and stem cankers.

Periodic annual volume growth decreased in all treatments from 32 to 37 years compared to the preceding period, except BA 85 (10-year) and Increasing BA. Average decrease was 47 ft^3; greatest reduction was on the check. Growth of the check plots declined by 87 percent to 21 ft^3 per acre net growth annually. Losses averaged 107 ft^3 yearly or five times growth. This drastic change was caused by mortality resulting from suppression in merchantable-size classes and insect infestations, probably because of the high level of stand density. Greatest growth occurred on the BA 95/115 treatment.

Performance over 20 years provides a better opportunity for appraisal than does performance over 5-year growth periods since the influence of short-term climatic changes is reduced. Net periodic annual volume growth excelled on the BA 100 and BA 95/115 plots;

Table 2.—*Net periodic annual cubic-foot volume growth (inside bark) from age 17 to 37 for merchantable trees*

Thinning treament	Age (years)				
	17 to 22	22 to 27	27 to 32	32 to 37	17 to 37
	Cubic feet				
BA 95/55	240	190	158	126	178
BA 70	200	221	161	149	183
BA 85	237	193	191	131	188
BA 85 (10-year)	223	282	146	170	205
Increasing BA	222	256	155	164	199
BA 100	245	263	201	176	221
BA 95/115	232	235	190	185	210
D+	194	208	211	156	192
Check	269	227	159	21	169

Table 3.—*Sawtimber volumes (International 1/4-inch rule) and log sizes*

Thinning treatment	Age 37, before cut			Cut, ages 27 and 32	Total net yield, age 37
	Volume per acre	Volume per tree	Avg. diameter saw log trees		
	Board feet		*Inch*	*Board feet*	
BA 95/55	12,667	181	13.3	3,875	16,542
BA 70	14,970	165	12.9	3,074	18,044
BA 85	16,432	152	12.5	1,998	18,430
BA 85 (10-year)	16,482	128	11.9	1,191	17,673
Increasing BA	17,306	131	12.1	1,576	18,882
BA 100	18,560	140	12.2	2,063	20,623
BA 95/115	18,752	121	11.8	765	19,517
D+	17,671	132	12.0	1,774	19,445
Check	16,809	108	11.5	0	16,809

increment was least on the check and BA 95/55 plots. Between BA 70 and 100, volume growth increased directly with residual basal area. For treatments in which residual basal area was held constant after each cut, growth increased an average of 19 ft^3 for each additional 15 ft^2 of basal area per acre.

The check plots fell below all thinning treatments mainly because of heavy mortality in the last 10 years. Over 20 years, thinning to BA 100 produced 31 percent more cubic-foot volume than did the check; BA 70 outgrew the check by 8 percent. Average basal area on the check increased from 114 to a high of 174 ft^2 per acre at age 32, then decreased to 167 ft^2 by age 37.

Mortality on thinned plots from age 17 to 37 was light, ranging from 2 to 12 ft^3 per acre annually; but 62 ft^3 was lost yearly on the check. Losses on the check were more than four times greater in the last 10 years than in the first 10. Mortality from suppression was serious only from age 27 to 37. Root rot was a major cause of mortality; why is not known.

Mean Annual Growth and Total Yield

Net mean annual cubic-foot volume growth at age 37 ranged from 138 (check) to 186 (BA 100) ft^3 per acre (fig. 1). Mean annual cubic-foot volume growth had not peaked by age 37 in any of the thinning treatments, although it culminated on the check between ages 27 and 32. A plateau was reached in five of the treatments (BA 70, BA 85, BA 85 (10-year), BA 95/55, and Increasing BA) between ages 27 and 32. The upward trend then resumed. On the check, however, the maximum was reached at age 32.

Total net yield ranged from 5,106 (check) to 6,882 (BA 100) ft^3 per acre. Yield at age 37 was 3.0 to 3.5 times larger than cubic-foot volumes had been at age 17.

Sawtimber Volume

Saw log volume estimates began at age 27, when 17 to 48 percent of the merchantable trees on the plots had reached saw log size. Standing saw log volume at age 37 ranged from 12,667 board feet (fbm) on BA 95/55 to 18,752 fbm on BA 95/115 (table 3). Volume at age 37 was related directly to residual density for plots with basal areas held constant since age 17. On these treatments, volume increased an average of 1,795 fbm for each 15-ft increase in residual density. Only four of the thinning treatments had produced more standing volume by age 37 than had the checks.

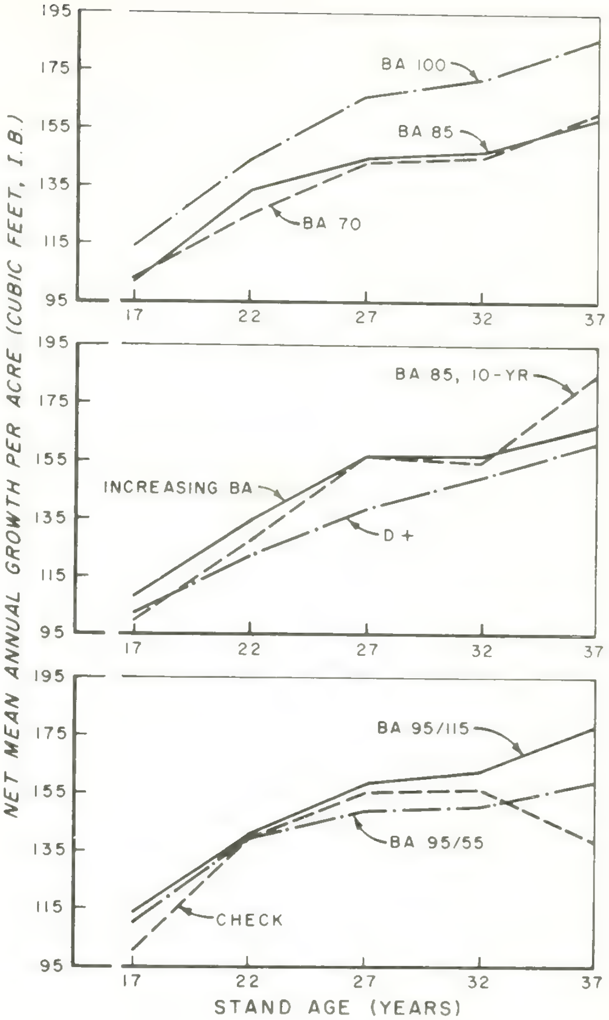

Figure 1.—*Net mean annual growth per acre in relation to stand age and thinning treatment.*

Thinning intensity had an effect on saw log volume per tree, which differed at age 37 by 60 fbm between BA 95/115 and BA 95/55. The least sawtimber volume per tree was on the check.

Average diameter of saw log trees was proportionate to the severity of cutting. A difference of 1.8 inches appeared between BA 95/55 and the check.

Total net sawtimber yield, like standing volume at age 37, also was related directly to residual density.

Diameter Growth

In the first 5 years of the study, periodic annual diameter growth of merchantable trees was related inversely to basal area per acre, ranging from a high of 0.26 inch on the BA 70 plots to a low of 0.20 inch on the check (table 4). Plots thinned to BA 70 grew 0.04 inch greater than those thinned to 100 ft^2 a difference of 18 percent, or an average of 0.02 inch for each 15 ft^2 of residual basal area. From age 22 to 27, diameter growth declined in those treatments where residual basal area increased, except for the D+ plots where the average rose from 0.24 to 0.27 inch.

Diameter increment in the third growing period was less than that in the preceding 5 years in all treatments, except BA 85 (10-year) which remained the same. Average decrease was 0.04 inch; greatest reduction occurred on the check. The decrease became greater as residual density increased. Treatment averages ranged from 0.11 to 0.33 inch per year, increasing with decreasing basal area levels from the check to the plots with 55 ft^2 of basal area per acre. Within the range of BA 55 to 115, diameter growth diminished by an average of 0.04 inch yearly for each 15-ft^2 increase in residual stocking.

In the last 5-year period, increment was less than in the preceding 5 years in all treatments. Decreases were greatest on plots with the least residual stocking and averaged 0.04 inch. Diameter increment for all treatments ranged from 0.08 to 0.26 inch per year, varying inversely with residual basal area. Within the range of thinning densities, annual diameter growth decreased an average of 0.03 inch for each 15 ft^2 increase in residual stocking.

Periodic annual diameter growth of merchantable trees from age 17 to 37 did not exceed 0.28 inch in any treatment. Twenty-year increment showed the same trend as did the shorter 5-year increments.

Diameter Distributions and Average Diameters

At age 37, average d.b.h. of merchantable trees ranged from 9.8 inches on the check to 13.3 inches on the most heavily cut plots, with other diameters related indirectly to basal area stocking (table 5).

Diameter distributions are more useful for evaluating responses to thinning treatments than are either diameter growth or average diameter. Trees per acre 13 inches d.b.h. and larger at age 37 ranged from 30 to 58 (table 5). Thinned plots had more large trees than did the checks, and heavily thinned plots generally had more large trees than did lightly thinned plots. Differences between treatments narrowed as the threshold diameter was lowered, and the check had as many or more trees 11 inches d.b.h. and larger than did all but three treatments. At a diameter of 10 inches, the check ranked first in trees per acre, and BA 95/115 was second. The percentage of sawtimber trees (10 inches d.b.h. and larger) ranged from 49 percent on the check to 99 percent on the BA 95/55 plots.

DISCUSSION

Average periodic annual volume growth over 20 years ranged from 169 to 221 ft^3 (i.b.) per acre, rising with increasing residual density. Thinning to 100 ft^2 per acre produced 10 cords more cubic-foot volume growth than did thinning to 70 ft^2 of basal area.

Trends in diameter increment were the opposite of those in volume growth. Merchantable trees on the BA 70 plots averaged 5.4

Table 4.—*Periodic annual diameter growth of merchantable trees from age 17 to 37 years*

Thinning treatment	17-22 years	22-27 years	27-32 years	32-37 years	17-37 years
	Inches				
BA 95/55	0.21	0.34	0.33	0.26	0.28
BA 70	.26	.30	.29	.23	.27
BA 85	.24	.26	.24	.20	.24
BA 85 (10-year)	.22	.21	.21	.16	.20
Increasing BA	.23	.24	.20	.17	.21
BA 100	.22	.22	.19	.17	20
BA 95/115	.22	.21	.16	.15	.18
D+	.24	.27	.22	.18	.23
Check	.20	.19	.11	.08	.14

Table 5.—*Numbers of trees per acre by 1-inch d.b.h. classes, before cutting at age 37, and average diameter*

Thinning treatment	D.b.h. - inches															Average diameter
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total	
	-*Number*-															*Inches*
BA 95/55	...	...	...	...	...	1	0	9	14	16	19	9	3	..	..	71	13.3
BA 70	...	...	...	1	0	4	5	16	12	33	15	8	2	...	..	96	12.7
BA 85	...	...	...	...	4	4	14	22	26	20	17	6	2	0	1	116	12.3
BA 85 (10-year)	1	2	3	4	8	32	28	25	39	25	7	5	..	...	..	179	11.1
Increasing BA	...	...	...	1	11	13	31	26	34	24	7	7	3	.	.	157	11.7
BA 100	...	...	...	5	2	16	22	28	42	28	5	4	3	1	...	156	11.7
BA 95/115	...	...	...	4	7	21	39	48	33	16	9	7	3	...	...	187	11.4
D+	...	...	...	1	0	12	22	41	35	20	12	3	1	...	...	147	11.7
Check	4	7	23	32	46	52	55	41	30	21	6	2	0	1	...	320	9.8

inches of growth from ages 17 to 37; the BA 100 plots averaged 1.4 inches less.

On a percentage basis, the BA 70 thinning produced 17 percent less cubic-foot volume than did the BA 100 over the 20-year growth period; diameter growth with light thinning was 26 percent less than with heavy thinning.

Previous thinning studies with slash pine indicated that thinning for short rotations would play a minor role in the development of a plantation where pulpwood was the main product goal. In the first 10 years of this study, net cubic-foot volume growth on the unthinned checks was equivalent to that of lightly thinned plots. Twenty-year results showed that net growth on the check was less than on the thinned plots because of the drastic increase in mortality on the unthinned check between ages 27 and 37. From age 17 to 27, mortality averaged 24 ft^3 yearly on the check; but from 27 to 37, mortality averaged 100 ft^3 yearly, or more than four times the losses in the first 10 years.

Sawtimber volume was excellent at age 37 on the unthinned treatment, averaging only 10 percent less standing volume than did BA 95/115 plots, which had the highest volume. This difference probably will narrow in the next 5 years because ingrowth into the saw log classes was advanced more on the BA 95/115 than it was on the check plots.

West Gulf industrial landowners operating on sites similar to this one and rotations of less than 30 years will not find thinning beneficial because it does not increase cubic-foot volume sufficiently compared to no thinning. However, small landowners interested in longer rotations and sawtimber production can enjoy early and periodic returns from thinning while improving the growth and quality of their sawtimber. Those wishing to harvest saw logs as soon as possible should make early and repeated thinnings. However, stands cut back to residual basal area levels of less than 80 ft^2 per acre do not occupy the growing space fully, and occasional mortality will create openings that lower the degree of stocking. Lighter thinnings at regular, short intervals offer inherent safeguards and give the landowner flexibility to make management decisions.

Thinning converts potential mortality into profit. However, the costs of thinning should be weighed against the monetary return and growth advantages. Also, getting a logger or pulpwood producer to do a good job of selective thinnings, especially in the lower diameter classes, may be difficult.

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Conversion to Metric Units

Cubic meters per hectare = Cubic feet per acre ÷ 14.2913

Square meters per hectare = Square feet per acre ÷ 4.356

Number per hectare = Number per acre × 2.471

Centimeters = Inches × 2.54

Meters = Feet × 0.3048

FEDUCCIA, DONALD P.

1979. Thinning planted slash pine on cutover flatwood sites in the West Gulf. U.S. Dep. Agric. For. Serv. Res. Pap. SO-158, 8 p. South. For. Exp. Stn., New Orleans, La.

Compares results of eight thinning regimes and an unthinned check for planted slash pine from ages 17–37. Net cubic-foot volume increased as residual basal area increased, except in check plots. Sawtimber production also increased as residual basal area increased, but only four thinning treatments did better than the check.

Additional keywords: *Pinus elliottii* var. *elliottii*, growth and yield, diameter distribution, sawtimber production.

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Growth and Yield in Managed Natural Stands of Loblolly and Shortleaf Pine in the West Gulf Coastal Plain

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Southern
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Station

SUMMARY

Second-growth even-aged loblolly-shortleaf pine stands on good and medium sites were thinned from above or below to a basal area of 70 ft^2, 85 ft^2, and 100 ft^2/acre, to an increasing basal area, or according to the judgment of a committee. Treatments began at age 20 for original plots and at age 25 for supplementary plots (on good sites only), which were thinned to a basal area of 55 ft^2, 115 ft^2, or 130 ft^2/acre. Stands were thinned every 5 years.

At age 45, most trees in good-site original plots and supplementary plots thinned from below were in the 10-inch d.b.h. class and larger. In the 70-ft^2, 85-ft^2, and "increasing" treatments, most stems were in the 15-inch class and larger.

On good-site original plots thinned from below, at 45 years standing sawtimber volume for trees $\geq$9.6 inches d.b.h. containing $\geq$ one 16-ft log to an 8-inch top was greatest in "increasing" treatment plots and least in 85-ft^2 and 100-ft^2/acre plots. In supplementary plots, standing board-foot volume was greatest in 130-ft^2 and least in 55-ft^2/acre plots. On medium sites, standing volume was greatest in "judgment" and 100-ft^2 and least in 70 ft^2/acre plots.

Sawtimber m.a.i. was still increasing rapidly at age 45 in all treatments. Cubic-foot m.a.i. was increasing slowly on medium sites but declining in supplementary plots and in all good-site original plots except the 70-ft^2 and "increasing" treatments. On good sites, p.a.g. in board feet culminated between ages 30 and 35 in the 70-ft^2 and 85-ft^2 treatments and between ages 40 and 45 in "increasing" plots. On medium sites, p.a.g. apparently was still increasing at 45 years. On both sites, sawtimber ingrowth was much less complete at age 45 in thin-from-above stands than in those thinned from below.

On good sites, sawtimber yield to age 45 in plots thinned from below was greatest in "increasing" treatment plots and least in 100-ft^2/acre stands. In supplementary plots, sawtimber yield was greatest in 55-ft^2 and least in 115-ft^2/acre treatments. On medium sites, sawtimber yield was greatest in "judgment" and 100-ft^2 and least in 70-ft^2/acre stands.

On good sites, cubic-foot yield to age 45, in peeled stemwood to a 3-inch d.i.b., trees $\geq$ 3.6 inches d.b.h., in plots thinned from below, was greatest for "increasing" treatment plots and least for 70-ft^2 stands. In supplementary plots, cubic-foot yield was greatest for 130-ft^2 and least for 55-ft^2/acre plots. On medium sites, cubic-foot yield was greatest for 100-ft^2 and least for 70-ft^2/acre stands.

This study is a cooperative effort with the Crossett Division, Georgia-Pacific Corp. Plots are on company land, and company personnel participated in periodic remeasurements and thinnings.

1980

Growth and Yield in Managed Natural Stands of Loblolly and Shortleaf Pine in the West Gulf Coastal Plain

J. D. Burton

INTRODUCTION

A thinning study in even-aged second-growth loblolly-shortleaf pine (*Pinus taeda* L. and *P. echinata* Mill.) stands is being conducted near Crossett, Arkansas. This study has told us how thinning method and stand density affect tree size, standing volumes at different ages, growth rates, and total yields on good and medium pine sites in the West Gulf Coastal Plain. Results will enable forest landowners to prescribe more precisely thinning regimes consistent with management objectives. This paper summarizes results from age 20, when thinning was initiated, through age 45. Growth and yields are reported in cubic feet, board feet International ¼-inch rule, and board feet Doyle rule.

METHODS AND MATERIALS

Two experimental areas were selected: an area of good sites in Ashley County, Arkansas and an area of medium sites in Morehouse Parish, Louisiana. In winter 1949-50, twenty-seven 0.1-acre circular plots, each surrounded by a 33-foot-wide isolation zone, were established in each of the two areas.

Site Quality

The good-site plots are on nearly level uplands. Soils are mainly Grenada and Calloway silt loams. Loblolly pine site index, determined before the first thinning at age 20 and based on curves in U.S. Department of Agriculture, Forest Service (1976), averaged 90 ft at 50 years (table 1); individual plot means ranged from 85 ft to 100 ft.

Medium-site plots are on broad, low, island-like ridges in the Ouachita River floodplain. These ridges are flooded every 4 or 5 years. Soils are silt loams in the Wrightsville-Leaf association with some patches of Frizzell. Site index immediately before initial thinning, based on curves in U.S. Department of Agriculture, Forest Service (1976), averaged 73 ft at 50 years; plot means ranged from 69 ft to 79 ft.

Timber Type

Good-site plots were established in volunteer shortleaf pine-loblolly pine-hardwood stands. These stands originated after the virgin timber was cut to a 12-inch d.b.h. limit during 1927 through 1930. This cut left two seed trees per acre. Many hardwoods, some quite large but unmerchantable at that time, also were left standing.

About 1918, virgin timber on medium sites was cut to a 14-inch d.b.h. limit. During the next 10 years, very hot wildfires burned the entire area three times and killed many large residual trees. The present stand grew from the 1929 seed crop, and no charring was evident 20 years later when the study began. No more cutting was done in either area before 1949 when most residual pines and hardwoods were still standing and had grown very large. When study plots were laid out, these old trees were avoided, so growth in the plots was not suppressed by the overstory.

Because inventory procedures did not identify species, relative proportions of shortleaf and loblolly pine are unknown.

Stocking Before Initial Thinning

All these young stands were well stocked. Before being thinned at age 20, good-site plots had 892 pines/acre $\geq$3.6 inches d.b.h. (range 773 to 1,009 by plots), basal area of 140 ft^2/acre, and mean d.b.h. (d.b.h. of tree of mean basal area) of

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Table 1.—*Site index as determined before initial thinning and as determined at age 45 for plots thinned from below*

Thinning level	Thinning method	Site index at 50 years			
		Good sites		Medium sites	
		Initial[a]	Age 45[b]	Initial[a]	Age 45[c]
ft²/acre		*trees per acre*			
70	Above	92	....	71	....
	Below	94	93	71	75
85	Above	88	.	73	....
	Below	88	93	78	81
100	Above	90	..	75	....
	Below	88	91	73	80
"Incr."	Above	89	..	73	....
	Below	89	93	73	81
"Judg."	Both	96	95	73	80
55	Below	95	96	..	....
115	Below	93	95		....
130	Below	91	95	....	...

[a] At age 20 in all original plots, at age 25 in 55 ft², 115 ft², and 130 ft²/acre plots using curve in U.S. Department of Agriculture, Forest Service (1976).

[b] Zahner's (1962) curves for loessial soils were used.

[c] Zahner's (1962) curves for poorly aerated soils were used.

5.4 inches. Sixty-two percent of the cubic-foot volume of stemwood inside bark to a 3-inch top diameter inside bark (d.i.b.) was in the 6-inch d.b.h. class and larger, 15 percent (22 trees/acre) was in the 8-inch class and larger, and 1.2 percent (4 trees/acre) was in the 10-inch class and larger. And 1,162 pines/acre were ≥1.6 inches d.b.h., had a basal area of 152 ft²/acre, and had a mean d.b.h. of 4.9 inches.

Before the first thinning at age 20 on medium sites, 880 pines/acre were ≥ 3.6 inches d.b.h. (range 823 to 950 by plots), had a basal area of 117 ft²/acre, and had a mean d.b.h. of 4.9 inches. Forty percent of the cubic-foot volume to a 3-inch top was in the 6-inch d.b.h. class and larger; 4 percent of the volume (14 trees/acre) was in the 8-inch class and larger. And 1,054 pines/acre were ≥ 1.6 inches d.b.h., had a basal area of 144 ft², and had a mean d.b.h. of 4.2 inches.

Mean total height of the dominant and codominant 20-year-old pines was 46 ft on good sites and 37 ft on medium sites.

Supplementary Plots

In winter 1954-55, nine more plots were laid out on good sites next to the good-site plots already established. Loblolly pine site index, determined before thinning at age 25, based on curves in U.S. Department of Agriculture, Forest Service (1976), averaged 93 ft (table 1); plot means ranged from 87 ft to 95 ft. These supplementary plots increased the range of stand densities. Supplementary plots, still unthinned at age 25, had 632 pines/acre, with basal area averaging 171 ft²/acre in trees ≥3.6 inches d.b.h. (range 490 to 780 by plots) and with a mean d.b.h. of 7.0 inches. Ninety-four percent of the cubic-foot volume inside bark to a 3-inch d.i.b. was in the 6-inch class and larger; 67 percent of the volume (81 trees/acre) was in the 8-inch class and larger; and 24 percent (54 trees/acre) was in the 10-inch class and larger. And 663 pines/acre were ≥1.6 inches d.b.h. (range 490 to 830 by plots), had a basal area of 172 ft²/acre, and had a mean d.b.h. of 6.9 inches.

Hardwood Control

In every plot, hardwoods ≥3.6 inches d.b.h. were cut when plots were first thinned. All remaining hardwoods were killed with a weed-killing chemical. In 1959, all hardwood sprouts ≥ 1.0 inch in diameter at the root collar were killed by an injection of a weedkiller. On good-site plots, original and supplementary, a dense, vigorous understory of hardwood sprouts, shrubs, and vines developed after each thinning. On medium sites, the understory was feeble. In every good-site plot, original and supplementary, all hardwoods ≥ 1.0 inch at root collar were cut before every inventory through age 40.

Plot Establishment and Treatments

Nine treatments were randomly replicated three times on both good and medium sites:

Thinning initially from above to a basal area of 70 ft^2, 85 ft^2, or 100 ft^2/acre at ages 20 and 25; thinnings at 30, 35, 40, and 45 years were from below, always to the originally assigned density in each plot.

Thinning initially from above to a basal area of 70 ft^2/acre at age 20, increasing to 75 ft^2/acre at age 25, then thinning from below to 80 ft^2 at age 30, to 85 ft^2 at age 35, to 90 ft^2 at age 40, and to 95 ft^2 at age 45.

Thinning from below to a basal area of 70 ft^2, 85 ft^2, or 100 ft^2/acre at age 20 and at 5-year intervals to the same densities.

Thinning from below to a basal area of 70 ft^2/acre at age 20, increasing to 75 ft^2 at age 25, to 80 ft^2 at 30 years, to 85 ft^2 at 35 years, to 90 ft^2 at 40 years, and to 95 ft^2 at 45 years.

Thinning according to the consensus of participating personnel, with no restrictions on method or intensity; this was called the "judgment" treatment. The basal area left after each thinning varied considerably between thinnings and between plots within thinnings. Basal area ranged by plot from 67 ft^2 to 81 ft^2/acre and averaged about 75 ft^2/acre on both sites. "Judgment" thinning was partly from above but mostly from below.

No unthinned control treatment was established.

For all thinning treatments, if trees were of equal quality, field workers cut shortleaf and kept loblolly pines. Reasonably uniform spacing between trees was maintained.

Thinning from above favored well-formed, relatively smooth codominant and intermediate trees by removing most dominants. Those suppressed merchantable trees apt to die within 5 years were cut, as were defective and poorly formed trees, regardless of crown class.

In thinning from below, dominants were favored, and competing trees in other crown classes were removed. Where removing coarse-limbed or misshapen dominants was desirable, codominants were left.

Supplementary plots were thinned from below to a basal area of 55 ft^2, 115 ft^2, or 130 ft^2/acre and at 5-year intervals to the same residual densities.

Since thinning from above at ages 20 and 25 removed the most vigorous trees, average total height of the 50 tallest trees/acre, from age 35 onward, was noticeably less in thin-from-above plots than in thin-from-below plots: this difference averaged 3 feet on both sites, although it varied among inventories, and it usually was greater on good sites than on medium. Researchers determined 50-year site index at age 45 only for plots thinned from below, using Zahner's (1962) curves for loessial soil in good-site original and supplementary plots and his curves for poorly aerated soils for medium-site plots. The age-45 site index determinations (all treatments averaged) exceeded the age-20 and age-25 values by 3 ft on good-site original plots, 6 ft on medium sites, and 4 ft on supplementary plots.

Changing attitudes on how to treat basal area in submerchantable trees (trees 1.6 -3.5 inches d.b.h.) resulted in varying thinning procedures till age 30. When the original plots were first thinned, researchers included only merchantable pine trees in computing basal area and in selecting trees to cut. Most plots contained many submerchantable trees; their numbers varied widely between plots within treatments; so, plots treated alike were not alike in density, stand structure, and competition intensity. Thinning at age 25 again removed only merchantable stems, but the designated residual basal area included submerchantable trees. So, residual basal area in 3.6-inch and larger trees averaged 7 ft^2/acre less than prescribed stand densities, but the deficit was as much as 21 ft^2/acre on individual plots. All submerchantable stems were cut at age 30. After age 30, residual stands consisted entirely of trees 3.6 inches d.b.h. and larger.

Violent winds destroyed or damaged many trees on good sites during the 41st growing season. Distribution and severity of damage were related to the storm track and were not caused by thinning. During the next 4 years, many trees on good sites and a few on medium sites were killed by the southern pine beetle (*Dendroctonus frontalis* Zimm.). Beetle-caused mortality was not related to site quality, but was more severe on lightly thinned than on heavily thinned plots.

Measurements and Analysis

The 54 original and 9 supplementary plots, from 1954 onward, were inventoried and thinned as one study. Merchantable height to an estimated 3-inch top d.i.b. was measured with a handheld altimeter. And d.b.h. was measured with a diameter tape on every tree. Total height was measured on sample trees. Using ladders, diameter tapes, and Swedish bark gages, field workers collected data for Girard form class.

Board-foot volumes (Doyle and Int. ¼) were obtained from the form-class volume tables of Mesavage and Girard (1946). Board-foot volumes were determined for trees $\geq$ 9.6 inches d.b.h. containing at least one 16-ft log to a top diameter outside bark (d.o.b.) of about 8 inches. Cubic-foot volume of pulpwood inside bark to a 3-inch top d.i.b. in trees $\geq$ 3.6 inches d.b.h. was reckoned from Mesavage's (1947) tables.

In this paper, standing volume means cubic-foot or board-foot volume of stemwood per acre in living pine trees before thinning at any specified age. Total yield to any age consists of standing volume plus volume in all previous merchantable thinnings plus volume in natural mortality occurring in merchantable trees after age 30. Net yield at any age includes standing volume plus volume in merchantable thinnings. The difference between total yield and net yield is natural mortality. No record was made of mortality before age 30, but it probably was confined almost entirely to submerchantable trees.

Because of a large spread in standing volume amounts before initial thinning, I had to calculate an adjusted initial cut before computing later cubic-foot yields. In good-site original plots, standing volume at age 20 ranged from 1,269 ft^3 to 2,000 ft^3 and averaged 1,471 ft^3/acre; on medium sites, standing volume ranged from 810 ft^3 to 1,572 ft^3 and averaged 1,261 ft^3/acre; in supplementary plots at age 25, standing volume ranged from 2,580 ft^3 to 3,967 ft^3 and averaged 3,246 ft^3/acre. Average merchantable yield before initial thinning was calculated for each of the three groups of plots: good-site original, medium-site, and supplementary. Adjusted initial cut for each plot was: the group pre-thinning average minus the individual plot residual cubic-foot volume.

No adjustment was needed for board-foot yield.

Using analysis of variance, I evaluated treatment-associated differences in:

1. Adjusted cubic-foot yield to ages 25 through 45,
2. Unadjusted standing cubic-foot volume at ages 25 through 45,
3. Unadjusted board-foot yield at ages 30 through 45,
4. Unadjusted standing board-foot volume at ages 30 through 45,
5. Adjusted periodic annual cubic-foot volume growth by 5-year periods from age 20 through age 45, and
6. Adjusted mean annual cubic-foot volume growth to ages 25, 30, 35, 40, and 45.

Separate analyses were made of data from good-site original plots, medium-site plots, and supplementary plots. Level of significance was 0.05. Single-df comparisons were orthogonal.

RESULTS

Thinning method caused few differences in relationships among treatments. And, because most commercial, non-mechanical thinning of natural stands of southern pines is done mainly from below, I will refer to thin-from-above treatments only when their results are significantly different.

Diameter Growth and Diameter Distribution

Bole diameter growth in good-site origina plots from age 20 to age 45 was most rapid in the 70-ft^2/acre plots, slowest in the 100-ft^2 (fig. 1) Mean d.b.h. in the "increasing" treatment was almost the same as mean d.b.h. in the 70-ft^2 treatment till age 30. Then, "increasing" residua basal area was 80 ft^2/acre; thereafter the "increasing" matched the 85-ft^2 plots' mean d.b.h At age 40 in "increasing" plots, residual basa area was 90 ft^2/acre, so the 85-ft^2 curve soon rose above the curve for the "increasing" treatment And although standing basal area at age 45 was about the same for the 100 ft^2 treatment and the "increasing" treatment, mean d.b.h. was much larger for the "increasing" treatment (14.6 inches) than for the 100-ft^2 treatment (12.5 inches).

Mean d.b.h. in good-site supplemental plots was greatest in heavily thinned plots, least in lightly thinned plots from age 35 onward. At age 40, before thinning, mean d.b.h. was 15.4 inches in the 55-ft^2, 12.4 in the 115-ft^2, and 11.9 inches in the 130-ft^2 treatment (fig. 2).

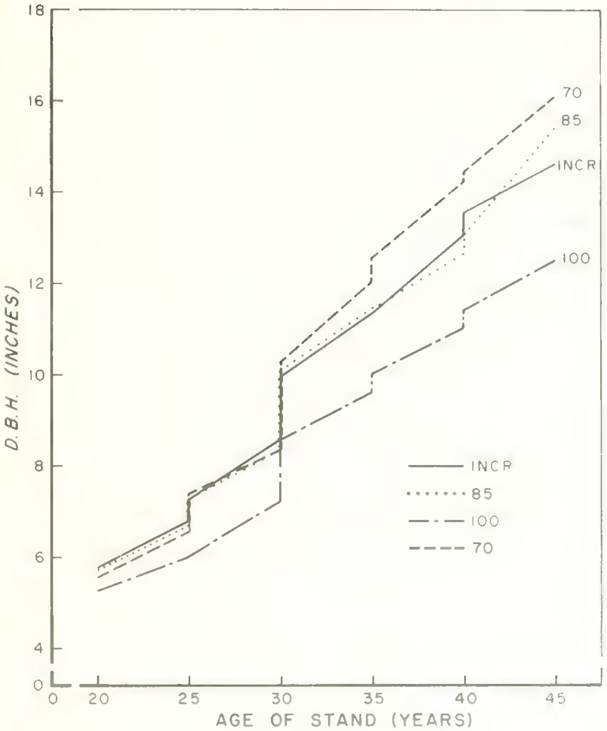

Figure 1.—Mean d.b.h. by treatment in stands thinned from below on good sites, based on all surviving pine trees ≥ 3.6 inches d.b.h. at each inventory.

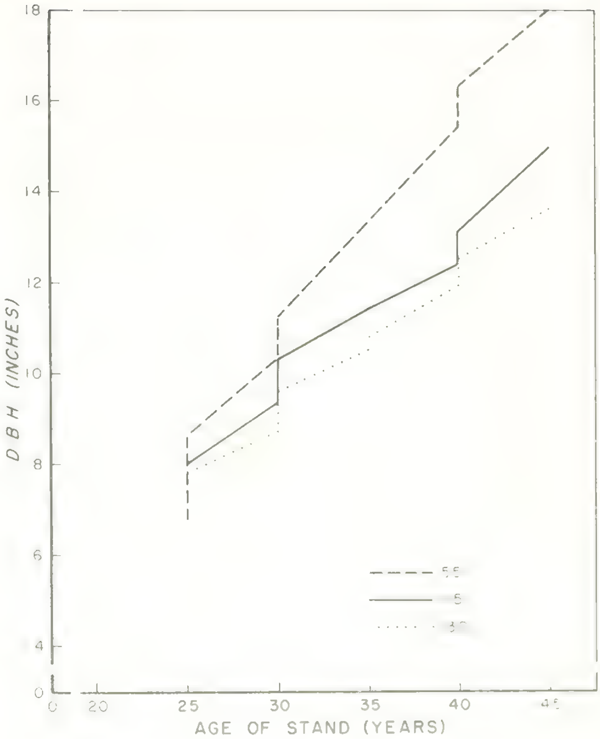

Figure 2.—Mean d.b.h. in supplementary plots, based on all surviving pine trees ≥ 3.6 inches d.b.h. at each inventory.

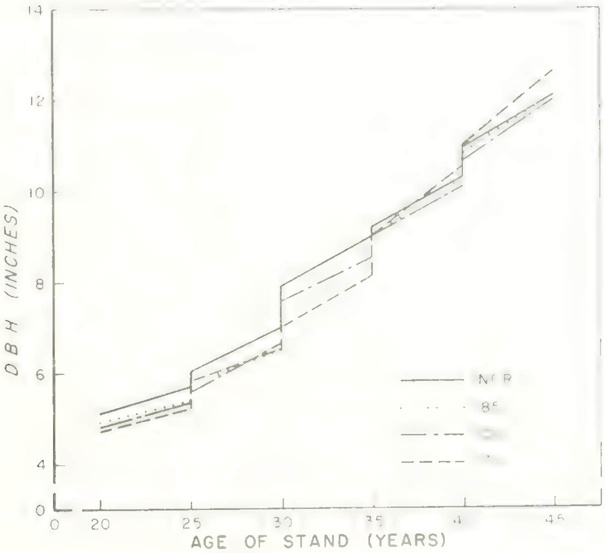

Figure 3.—Mean d.b.h. by treatment in stands thinned from below on medium sites, based on all surviving pine trees ≥ 3.6 inches d.b.h. at each inventory.

Mean d.b.h. on the medium sites responded only weakly and very slowly to thinning levels (fig. 3).

Table 2 shows diameter distribution on good sites after thinning at age 20. Tables 3-7 show diameter distribution on good sites (original plots and supplementary plots) before thinning at ages 25, 30, 35, 40, and 45.

Just after initial thinning at age 20, 76 to 97 percent of the merchantable trees were in three d.b.h. classes. At age 25 before thinning, the majority (85 to 98 percent) had spread through five (4- through 8-inch) classes. At age 30, merchantable trees were distributed through a wide range of d.b.h. classes. Light thinning widened the range of classes more than did heavy thinning. Thinning from above widened the range more than thinning from below. At age 35, all trees in the 70 ft and 89 percent in the "increasing" thin-from-below plots were in the 10-inch class and larger.

Table 8 shows diameter distribution on medium sites after thinning at age 20. Tables 9-13 show diameter distribution on medium sites before thinning at ages 25, 30, 35, 40, and 45.

After the first thinning at age 20, most (70 to 87 percent) of the merchantable trees on medium sites were in two d.b.h. classes. The range of classes began to expand immediately and continued to increase through age 45.

Cubic-foot Growth and Yield

Standing Volumes.—Standing volumes before each thinning represent the resource available for immediate liquidation if the rotation were to be ended at that age. Except where catastrophic losses occurred, standing cubic-foot volumes in this study increased with age and were greater in lightly thinned than on heavily thinned plots. The result from thinning from above was usually not much different from the result from thinning from below. Differences among the 70-ft^2, 85-ft^2, and 100-ft^2 thinning levels were significant at every inventory from age 25 onward on medium sites and from age 30 onward on good sites. Differences between the 55-ft^2 and the 115-ft^2 and 130-ft^2 combined were significant at every inventory from age 30 onward. There were no significant differences between the 115-ft^2 and the 130-ft^2 treatments.

Tables 14-18 show distribution of standing cubic-foot volume on good-site original plots and supplementary plots. On original plots at age 25, 4 to 18 percent (average 11 percent) of standing cubic-foot volume was in 10-inch and larger trees; in supplementary plots, which were still unthinned at age 25, 19 to 29 percent (average 24 percent) of standing cubic-foot volume was in sawtimber-sized trees (table 14).

Tables 19-23 show distribution of standing cubic-foot volume on medium-site plots. At every inventory, from age 25 through age 45, standing cubic-foot volume increased as stand density increased; among the 70-ft^2, 85-ft^2, and 100-ft^2 levels this effect was significant. Only at age 30 was any difference associated with thinning from above or below—thin-from-below plots contained significantly more volume than did thin-from-above plots.

Total Yields.—Yield in cubic feet of stemwood inside bark to a 3-inch top d.i.b. was greatest under the lightest thinnings, least under the heaviest thinnings. These effects were significant at ages 35 and 40 on good-site original plots and at ages 25 through 45 on medium sites; on supplementary plots, these differences were not significant.

Total yield to age 30 averaged 3,593 ft^3/acre on good-site original plots, 2,536 ft^3/acre on medium sites, and 3,992 ft^3/acre on supplementary plots. Yield to age 40 averaged 5,935 ft^3/acre on good-site original, 4,736 ft^3/acre on medium-site, and 6,411 ft^3/acre on supplementary plots.

Net yield was equal to total yield through age 45 in the good-site 70-ft^2 plots; no trees died after age 30 (fig. 4). Nor did any mortality occur after age 30 in 55-ft^2 plots; in all other thin-from-below treatments on good-site original and supplementary plots, some trees died. On medium sites, mortality was light and showed little effect of treatment.

The greatest total adjusted 45-year yields in good-site original plots thinned from below were in "increasing" plots (6,949 ft^3/acre) and 100 ft^2 plots (6,666 ft^3/acre). Net yield was 6,186 ft^3/acre in 100 ft^2 plots and 6,416 ft^3/acre in 70 ft^2 plots. Greatest total yields in supplementary plots occurred in 130-ft^2 (7,442 ft^3/acre) and 115-ft^2 (7,156 ft^3/acre) treatments at 45 years. Greatest net cubic-foot yields were in 55-ft^2 (6,608 ft^3/acre) and 130 ft^2 (6,468 ft^3/acre) plots.

Greatest total yield (6,089 ft^3/acre) and net yield (6,049 ft /acre) at age 45 on medium sites resulted from thinning from below to a basal area of 100 ft^2 (fig. 5). Net yields from 85 ft^2 and "increasing" stand densities were slightly less,

Table 2.—*Diameter distribution of trees per acre on good sites after thinning at age 20*

Thinning level	Thinning method	D.b.h. (inches)								Total	
		2&3	4	5	6	7	8	9	10	≥4	≥2
ft^2/acre		---trees per acre---									
70	Above	127	120	130	83	43	27	10	0	413	540
	Below	340	117	123	117	43	23	3	0	426	766
85	Above	270	223	187	103	50	17	0	0	580	850
	Below	200	113	150	107	80	27	7	3	487	687
100	Above	103	147	200	147	80	20	3	0	597	700
	Below	280	227	210	133	63	17	0	3	653	933
"Incr."	Above	480	267	213	70	17	0	0	0	567	1047
	Below	300	100	90	113	60	23	0	7	393	693
"Judg."	Both	327	163	147	97	57	27	0	0	490	817

Table 3.—*Diameter distribution of trees per acre on good sites before thinning at age 25*

Thinning level	Thinning method	D.b.h. (inches)											Total	
		2&3	4	5	6	7	8	9	10	11	12	13	≥4	≥2
ft^2/acre		---trees per acre---												
70	Above	20	60	70	100	70	40	27	13	13	0	0	393	413
	Below	147	73	80	113	80	60	27	10	3	0	0	446	593
85	Above	142	117	167	120	97	50	30	7	0	0	0	588	730
	Below	104	73	80	114	90	47	53	13	3	3	0	476	580
100	Above	31	83	133	107	103	73	33	10	3	0	0	545	576
	Below	106	167	150	147	107	57	23	3	0	3	0	657	763
"Incr."	Above	204	200	130	173	63	33	10	0	0	0	0	609	813
	Below	67	60	60	93	63	77	30	20	0	3	0	406	473
"Judg."	Both	147	100	80	107	93	60	33	7	0	0	0	480	627
55	Below	47	97	120	153	80	80	67	17	23	3	3	643	690
115	Below	18	70	93	123	90	83	77	40	23	0	3	602	620
130	Below	28	67	123	113	130	80	93	30	3	10	3	652	680

Table 4.—*Diameter distribution of trees per acre on good sites before thinning at age 30*

Thinning level	Thinning method	D.b.h. (inches)														Total	
		2&3	4	5	6	7	8	9	10	11	12	13	14	15	16	≥4	≥2
ft^2/acre		---trees per acre---															
70	Above	9	13	40	37	33	70	37	27	17	10	0	7	3	0	294	303
	Below	56	53	10	17	17	37	60	30	30	10	3	3	0	0	270	326
85	Above	37	83	50	87	70	53	57	30	13	7	3	0	0	0	453	490
	Below	27	37	37	17	33	43	27	53	40	10	3	3	0	0	303	330
100	Above	7	43	70	77	53	80	63	37	13	10	3	0	0	0	449	456
	Below	40	73	70	63	87	63	67	40	7	10	0	0	0	0	480	520
"Incr."	Above	100	100	63	60	83	60	33	17	10	0	0	0	0	0	426	526
	Below	30	40	7	27	30	37	43	53	23	17	0	0	3	0	280	310
"Judg."	Both	66	80	23	27	50	47	43	53	17	7	0	0	0	0	347	413
55	Below	17	10	0	7	7	13	23	30	20	17	20	3	0	3	153	170
115	Below	6	7	7	37	33	30	50	63	30	27	13	0	3	0	300	306
130	Below	13	3	17	53	67	47	57	77	20	10	13	3	0	0	367	380

Table 5.—*Diameter distribution of trees per acre on good sites before thinning at age 35*

Thinning level	Thinning method	D.b.h. (inches)														Total
		5	6	7	8	9	10	11	12	13	14	15	16	17	18	5-18
ft²/acre		*trees per acre*														
70	Above	0	0	0	7	40	17	33	7	10	13	0	3	3	3	136
	Below	0	0	0	0	0	10	37	20	23	13	7	3	0	0	113
85	Above	0	3	7	43	30	40	23	20	13	3	7	0	0	0	189
	Below	0	0	3	3	27	10	43	47	13	3	7	0	0	0	156
100	Above	0	0	13	40	47	57	33	20	13	3	0	0	0	0	226
	Below	3	7	43	30	60	40	40	10	13	0	0	0	0	0	246
"Incr."	Above	7	20	43	40	73	33	17	7	10	0	0	0	0	0	250
	Below	0	0	3	0	13	40	33	30	20	10	0	0	0	0	149
"Judg."	Both	0	0	3	7	20	27	30	33	10	7	3	0	0	0	140
55	Below	0	0	0	0	0	3	13	20	10	20	10	7	0	0	83
115	Below	0	0	10	6	17	37	50	20	37	10	7	3	0	0	197
130	Below	0	3	23	33	47	30	63	17	13	10	0	7	3	0	249

Table 6.—*Diameter distribution of trees per acre on good sites before thinning at age 40*

Thinning level	Thinning method	D.b.h. (inches)														Total
		7	8	9	10	11	12	13	14	15	16	17	18	19	20	7-20
ft²/acre		*trees per acre*														
70	Above	0	3	0	3	20	17	20	7	7	7	0	7	0	3	94
	Below	0	0	0	0	3	13	13	23	17	7	7	0	0	0	83
85	Above	0	13	13	23	20	20	23	20	3	0	7	0	0	0	132
	Below	0	0	7	10	17	20	27	30	7	3	0	0	0	0	121
100	Above	0	17	7	23	47	27	10	23	3	7	0	0	0	0	164
	Below	13	13	17	53	27	27	17	3	13	0	0	0	0	0	183
"Incr."	Above	13	7	27	47	43	20	3	10	7	0	0	0	0	0	177
	Below	0	0	0	7	33	10	27	13	27	0	0	0	0	0	117
"Judg."	Both	0	3	0	17	3	27	23	13	10	7	3	0	0	0	106
55	Below	0	0	0	0	0	3	13	10	7	7	3	13	0	0	56
115	Below	7	7	7	20	17	30	23	30	10	3	7	0	0	0	161
130	Below	10	7	30	27	20	40	27	13	7	3	7	0	3	0	194

Table 7.—*Diameter distribution of trees per acre on good sites before thinning at age 45*

Thinning level	Thinning method	D.b.h. (inches)													Total
		9	10	11	12	13	14	15	16	17	18	19	20	22	9-22
ft²/acre		*trees per acre*													
70	Above	0	0	0	3	3	27	3	10	0	0	7	7	3	63
	Below	0	0	0	0	3	13	7	20	10	7	3	0	0	63
85	Above	0	0	13	13	20	13	17	10	0	3	3	0	0	92
	Below	0	0	0	0	3	7	13	23	0	3	0	0	0	49
100	Above	0	7	3	20	26	10	17	7	7	3	0	0	0	100
	Below	7	7	37	27	10	10	13	7	3	0	0	0	0	121
"Incr."	Above	0	13	20	33	20	10	3	10	3	0	0	0	0	112
	Below	0	0	0	20	7	17	17	23	7	0	0	0	0	91
"Judg."	Both	0	3	3	0	17	17	13	10	10	3	7	0	0	83
55	Below	0	0	0	0	0	0	0	7	7	7	7	10	0	38
115	Below	0	0	0	7	13	10	20	17	3	7	0	0	0	77
130	Below	7	10	7	17	33	17	17	0	7	3	0	3	0	121

Table 8.—*Diameter distribution of trees per acre on medium sites after thinning at age 20*

Thinning level	Thinning method	D.b.h. (inches)							Total	
		2&3	4	5	6	7	8	9	≥4	≥2
ft²/acre		*trees per acre*								
70	Above	363	230	183	70	23	13	0	519	882
	Below	733	300	210	67	7	3	0	587	1,320
85	Above	603	360	200	83	20	3	3	669	1,272
	Below	720	280	197	113	23	10	0	623	1,343
100	Above	427	270	203	133	60	10	3	679	1,106
	Below	670	383	247	107	30	7	0	774	1,444
"Incr."	Above	903	410	130	50	20	0	0	610	1,513
	Below	433	180	220	83	23	13	0	519	952
"Judg."	Both	763	283	177	60	13	3	3	539	1,302

Table 9.—*Diameter distribution of trees per acre on medium sites before thinning at age 25*

Thinning level	Thinning method	D.b.h. (inches)									Total	
		2&3	4	5	6	7	8	9	10	12	≥4	≥2
ft²/acre		*trees per acre*										
70	Above	157	183	187	137	70	20	13	0	0	610	767
	Below	424	243	207	153	57	13	3	0	0	676	1,100
85	Above	307	250	210	157	87	20	10	3	3	740	1,047
	Below	351	263	173	127	83	17	13	3	0	679	1,030
100	Above	202	217	187	173	77	43	17	7	0	721	923
	Below	330	280	240	187	103	23	7	0	0	840	1,170
"Incr."	Above	517	403	183	100	40	27	3	0	0	756	1,273
	Below	206	173	123	147	87	30	17	0	0	577	783
"Judg."	Both	443	233	187	153	63	17	0	7	0	660	1,103

Table 10.—*Diameter distribution of trees per acre on medium sites before thinning at age 30*

Thinning level	Thinning method	D.b.h. (inches)										Total	
		2&3	4	5	6	7	8	9	10	11	12	≥4	≥2
ft²/acre		*trees per acre*											
70	Above	75	83	87	87	107	47	20	10	0	0	441	516
	Below	227	110	33	60	70	73	33	7	3	0	389	616
85	Above	127	120	93	107	93	47	33	10	0	0	503	630
	Below	190	97	73	90	83	63	17	17	3	7	450	640
100	Above	73	87	127	93	103	60	43	7	7	0	527	600
	Below	156	87	70	117	97	100	43	10	0	0	524	680
"Incr."	Above	251	130	153	90	53	23	17	13	0	0	479	730
	Below	84	67	30	63	73	70	43	13	7	0	366	450
"Judg."	Both	242	127	60	107	90	67	30	17	0	3	501	743

Table 11.—*Diameter distribution of trees per acre on medium sites before thinning at age 35*

Thinning level	Thinning method	D.b.h. (inches)											Total
		4	5	6	7	8	9	10	11	12	13	15	4-15
ft²/acre		*trees per acre*											
70	Above	0	0	17	60	80	33	43	0	10	0	0	243
	Below	53	10	7	27	53	70	23	17	3	3	0	266
85	Above	0	17	33	77	80	43	37	23	0	0	0	310
	Below	7	20	40	43	57	63	37	7	10	7	3	294
100	Above	3	47	57	83	77	50	40	7	3	3	0	370
	Below	0	0	30	70	73	80	43	23	0	0	0	319
"Incr."	Above	50	53	103	70	57	17	30	10	3	0	0	393
	Below	0	0	7	47	47	63	47	13	13	0	0	237
"Judg."	Both	0	0	17	57	60	53	43	10	13	3	0	256

Table 12.—*Diameter distribution of trees per acre on medium sites before thinning at age 40*

Thinning level	Thinning method	D.b.h. (inches)												Total
		5	6	7	8	9	10	11	12	13	14	15	16	5-16
ft²/acre		*trees per acre*												
70	Above	0	0	7	23	63	30	27	10	10	0	0	0	170
	Below	0	0	3	27	23	53	17	13	13	3	3	0	155
85	Above	0	17	7	47	50	33	23	27	13	0	0	0	217
	Below	3	3	10	20	47	50	27	7	13	3	3	3	189
100	Above	3	27	30	50	40	53	27	17	7	3	0	0	257
	Below	0	0	10	37	43	63	27	37	10	0	0	0	227
"Incr."	Above	10	13	50	63	50	23	13	27	0	3	0	0	252
	Below	0	0	10	30	27	43	37	17	17	3	0	0	184
"Judg."	Both	0	0	0	13	23	30	48	20	13	3	3	0	153

Table 13.—*Diameter distribution of trees per acre on medium sites before thinning at age 45*

Thinning level	Thinning method	D.b.h. (inches)													Total
		6	7	8	9	10	11	12	13	14	15	16	17	18	6-18
ft²/acre		*trees per acre*													
70	Above	0	0	0	7	37	23	23	17	10	3	3	0	0	123
	Below	0	0	0	7	3	27	23	13	13	10	7	0	0	103
85	Above	0	0	13	30	20	13	20	17	27	7	0	0	0	147
	Below	0	0	7	7	23	27	37	10	10	3	3	3	3	133
100	Above	0	3	27	27	30	37	30	20	10	0	3	0	0	187
	Below	0	0	0	3	20	57	30	27	17	7	0	0	0	161
"Incr."	Above	3	7	27	33	54	20	7	20	13	0	0	0	0	184
	Below	0	0	3	7	13	37	27	33	10	10	0	0	0	140
"Judg."	Both	0	0	0	3	0	17	30	33	10	10	7	0	0	110

Table 14.—*Distribution of standing cubic-foot volume at age 25 among d.b.h. classes on good-site original plots thinned from below and on supplementary plots*

Thinning treatment	Proportion of standing volume in trees having d.b.h. in inches ≥:					Total volume
	4	6	8	10	12	
ft^2*/acre*	*percent*					*ft*^{3}*/acre*
70	100	90	50	10	0	1,905
85	100	92	54	12	3	2,173
100	100	82	34	5	3	2,129
"Incr."	100	93	59	15	3	1,918
"Judg."	100	89	44	4	0	1,918
55	100	93	65	23	4	3,037
115	100	95	71	29	2	3,262
130	100	94	65	19	7	3,438

Table 15.—*Distribution of standing cubic-foot volume at age 30 among d.b.h. classes on good-site original plots thinned from below and on supplementary plots*

Thinning treatment	Proportion of standing volume in trees having d.b.h. in inches ≥:							Total volume
	4	6	8	10	12	14	16	
ft^2*/acre*	*percent*							*ft*^{3}*/acre*
70	100	98	92	53	18	5	0	2,167
85	100	97	89	65	15	4	0	2,466
100	100	95	72	29	8	0	0	2,544
"Incr."	100	99	90	62	20	5	0	2,338
"Judg."	100	96	82	47	6	0	0	2,206
55	100	100	98	84	51	11	7	2,146
115	100	100	92	70	31	4	0	3,083
130	100	99	85	59	21	3	0	3,325

Table 16.—*Distribution of standing cubic-foot volume at age 35 among d.b.h. classes on good-site original plots thinned from below and on supplementary plots*

Thinning treatment	Proportion of standing volume in trees having d.b.h. in inches ≥:							Total volume
	4	6	8	10	12	14	16	
ft^2*/acre*	*percent*							*ft*^{3}*/acre*
70	100	100	100	100	62	19	5	2,637
85	100	100	99	87	57	11	0	3,178
100	100	100	90	58	18	0	0	3,350
"Incr."	100	100	99	93	52	10	0	3,039
"Judg."	100	100	99	86	49	12	0	2,681
55	100	100	100	100	87	52	12	2,443
115	100	100	99	92	56	21	4	3,763
130	100	100	96	75	37	19	11	3,996

Table 17.—*Distribution of standing cubic-foot volume at age 40 among d.b.h. classes on good-site original plots thinned from below and on supplementary plots*

Thinning treatment	Proportion of standing volume in trees having d.b.h. in inches ≥: 4	6	8	10	12	14	16	18	Total volume
ft²/acre				*percent*					*ft³/acre*
70	100	100	100	100	97	72	22	0	3,176
85	100	100	100	97	79	44	5	0	3,561
100	100	100	97	87	48	17	0	0	3,848
"Incr."	100	100	100	100	78	46	0	0	3,655
"Judg."	100	100	100	99	88	40	17	0	3,370
55	100	100	100	100	100	80	53	33	2,632
115	100	100	99	95	78	44	12	0	4,511
130	100	100	98	88	69	31	16	5	4,986

Table 18.—*Distribution of standing cubic-foot volume at age 45 among d.b.h. classes on good-site original plots thinned from below and on supplementary plots*

Thinning treatment	Proportion of standing volume in trees having d.b.h. in inches ≥: 8	10	12	14	16	18	20	Total volume
ft²/acre				*percent*				*ft³/acre*
70	100	100	100	97	71	21	0	3,271
85	100	100	100	96	59	9	0	2,310
100	100	98	66	37	14	0	0	3,408
"Incr."	100	100	100	80	42	0	0	3,921
"Judg."	100	100	96	81	47	18	0	3,787
55	100	100	100	100	100	71	33	2,493
115	100	100	100	81	44	7	0	3,349
130	100	98	90	53	21	12	7	4,443

Table 19.—*Distribution of standing cubic-foot volume at age 25 among d.b.h. classes on medium-site plots thinned from below*

Thinning treatment	Proportion of standing volume in trees having d.b.h. in inches ≥: 4	6	8	10	Total volume
ft²/acre		*percent*			*ft³/acre*
70	100	62	8	0	1,301
85	100	69	18	2	1,487
100	100	68	11	0	1,861
"Incr."	100	79	23	0	1,456
"Judg."	100	69	14	6	1,346

Table 20.—*Distribution of standing cubic-foot volume at age 30 among d.b.h. classes on medium-site plots thinned from below*

Thinning treatment	Proportion of standing volume in trees having d.b.h. in inches ≥:					Total volume
	4	6	8	10	12	
ft²/acre			*percent*			*ft³/acre*
70	100	92	58	8	0	1,291
85	100	89	51	20	7	1,667
100	100	92	56	6	0	2,013
"Incr."	100	95	65	15	0	1,550
"Judg."	100	90	50	13	4	1,612

Table 21.—*Distribution of standing cubic-foot volume at age 35 among d.b.h. classes on medium-site plots thinned from below*

Thinning treatment	Proportion of standing volume in trees having d.b.h. in inches ≥:						Total volume
	4	6	8	10	12	14	
ft²/acre			*percent*				*ft³/acre*
70	100	97	88	33	6	0	2,024
85	100	99	84	40	17	4	2,560
100	100	83	32	0	0	0	2,834
"Incr."	100	100	87	45	10	0	2,402
"Judg."	100	100	83	41	13	0	2,430

Table 22.—*Distribution of standing cubic-foot volume at age 40 among d.b.h. classes on medium-site plots thinned from below*

Thinning treatment	Proportion of standing volume in trees having d.b.h. in inches ≥:							Total volume
	4	6	8	10	12	14	16	
ft²/acre				*percent*				*ft³/acre*
70	100	100	99	79	35	8	0	2,549
85	100	100	98	74	31	14	6	3,148
100	100	100	98	73	33	0	0	3,549
"Incr."	100	100	98	78	31	3	0	3,111
"Judg."	100	100	100	85	33	4	0	2,857

Table 23.—*Distribution of standing cubic-foot volume at age 45 among d.b.h. classes on medium-site plots thinned from below*

Thinning treatment	Proportion of standing volume in trees having d.b.h. in inches ≥: 4	6	8	10	12	14	16	18	Total volume
ft²/acre	*percent*								*ft³/acre*
70	100	100	100	97	76	42	10	0	2,612
85	100	100	100	95	69	33	17	7	3,238
100	100	100	100	99	61	21	0	0	3,742
"Incr."	100	100	100	96	69	23	0	0	3,328
"Judg."	100	100	100	99	90	34	6	0	3,005

and yield from 70 ft^2 was noticeably less; all these differences were significant.

Andrulot et al. (1972) reported yields through age 50 of plots established by H. H. Chapman near Urania, Louisiana. Many differences exist between the two studies, but comparisons can be useful. In the tabulation below, the Urania study's net yields (including thinnings, excluding mortality) in total stands (including hardwood) and in pine only are arrayed with yields of the 70-ft^2, 100-ft^2, and "increasing" treatments in the Crossett study.

	Urania study		Crossett study		
Age of stand	Total stand	Pine only	Thinned from below to: 70 ft^2	100 ft^2	"Incr."
	ft³/acre				
25	2,652	2,482	2,684	2,654	2,709
30	3,439	3,251	3,492	3,581	3,641
35	4,208	4,009	4,615	4,901	4,909
40	4,901	4,696	5,657	6,000	6,081
45	5,460	5,251	6,416	6,666	6,949

So, total yields to a 3-inch top in the Crossett study were very similar to net yields of total stemwood in the Urania study. Crossett yields were a little larger than Urania yields, in part because Crossett plots were kept free of hardwood, in part because site index at Crossett was higher than the 88-foot average site index at Urania, and in part because early thinnings at Urania were more drastic than those at Crossett.

Periodic Annual Increment.—Periodic annual growth (p.a.g.) in cubic feet to a 3-inch top culminated between ages 30 and 35 in the good-site original plots and between ages 35 and 40 on medium sites. In supplementary plots, p.a.g. culminated between ages 30 and 35 in 55-ft^2 plots and between ages 35 and 40 in 115-ft^2 plots and 130-ft^2 plots (table 24).

Periodic annual growth, age 20 to 45, on good-site original plots thinned from below averaged 195 ft^3/acre (range 187 ft^3 to 208 ft^3/acre by treatments); on medium sites p.a.g. averaged 168 ft^3/acre (range 148 ft^3 to 193 ft^3/acre), though it declined suddenly for no apparent reason in the 100-ft^2 plots between 40 and 45 years. Periodic annual growth, age 25 to 45 in supplementary plots averaged 191 ft^3/acre for all treatments combined (range 168 ft^3 to 210 ft^3/acre).

The p.a.g. values in table 24 appear similar to those reported by Nelson et al. (1961) for a study in Georgia, South Carolina, and Virginia. But results of the two studies are not comparable for several reasons:

1. Cubic-foot volumes in the southeastern study were outside bark to a 4-inch top in trees ≥4.6 inches d.b.h.
2. Management and analysis procedures in the two studies differed greatly.
3. Stand basal area in the southeastern study included trees considered submerchantable in the Crossett study.
4. The southeastern plots, before their first thinning, had a range of density from 40 to 130 percent of full stocking. Crown lengths in the overstocked plots, especially in stands over 40 years old, must have been much shorter than crown lengths in trees of the same age in the Crossett study.
5. The Crossett study considers total growth, but the southeastern study dealt with net growth.
6. Different site index curves were used in the two studies.

Mean Annual Increment.—Mean annual increment (m.a.i.) in cubic feet was still increasing slowly on medium sites at age 45 (table 25). In supplementary plots and in two of the five good-site original thin-from-below treatments, cubic-

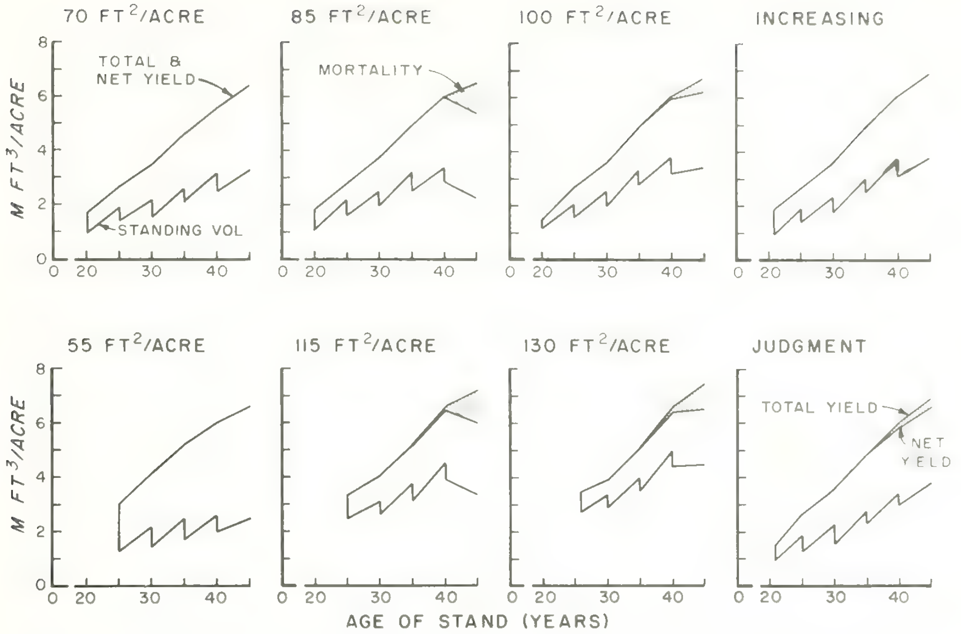

Figure 4.—Total and net cubic-foot yield, cumulative natural mortality, standing volume, and volume harvested in good-site original plots thinned from below and in supplementary plots: 70-ft^2, 85-ft^2, 100-ft^2, "increasing", "judgment", 55-ft^2, 115-ft^2, and 130-ft^2/acre treatments.

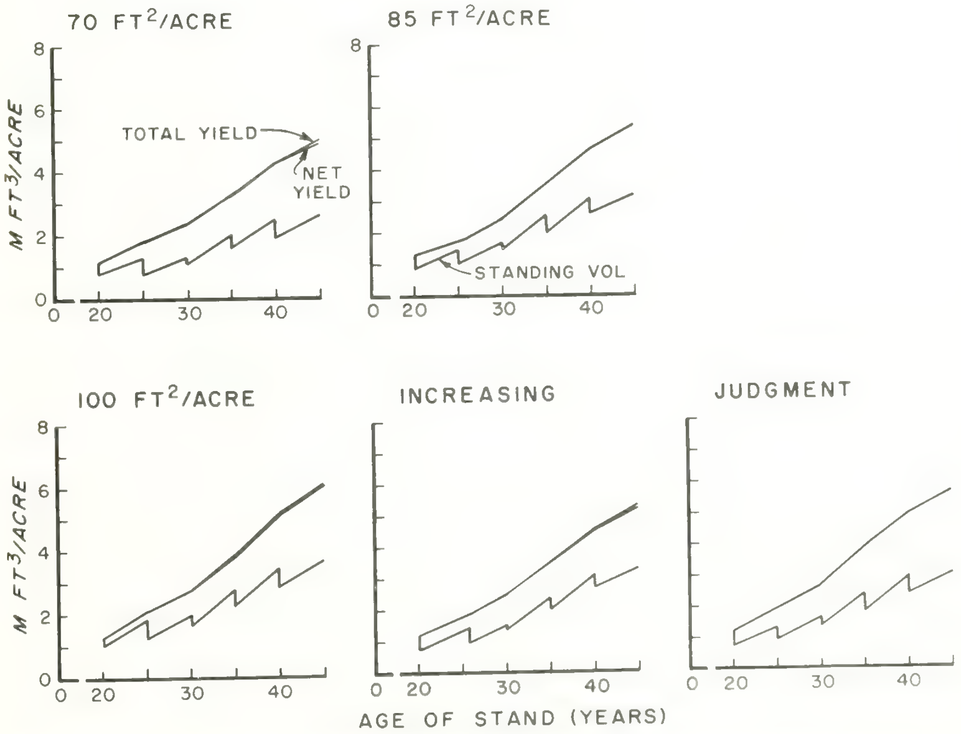

Figure 5.—Total and net cubic-foot yield, cumulative natural mortality, standing volume, and volume harvested in stands thinned from below on medium sites: 70-ft^2, 85-ft^2, 100-ft^2/acre, "increasing", and "judgment" treatments.

Table 24.—*Periodic annual growth in cubic-foot volume*[a]

Thinning treatment	Good sites, ages						Medium sites, ages					
	20-25	25-30	30-35	35-40	40-45	20-45	20-25	25-30	30-35	35-40	40-45	20-45
ft²/acre						*ft³/acre*[b]						
70	189	162	225	208	152	187	112	107	193	192	136	148
85	217	166	244	219	105	190	114	127	221	232	129	165
100	183	185	264	220	133	197	165	148	223	250	180	193
"Increasing"	194	186	254	234	174	208	125	110	207	228	129	160
"Judgment"	181	190	230	244	179	205	125	143	233	222	144	173
						--25-45--						
55	....	180	204	181	107	168	....	....	....	....	....	....
115	....	142	229	295	116	195	....	....	....	....	....	....
130	....	125	236	306	172	210	....	....	....	....	....	....

[a] Plots thinned from above were omitted from these calculations.

[b] Inside bark in trees $\geq$ 3.6 inches d.b.h. containing $\geq$ two 63-inch bolts to a 3-inch top d.i.b.

Table 25.—*Adjusted cubic-foot mean annual increment*[a]

Thinning treatment	Good sites to age					Medium sites to age				
	25	30	35	40	45	25	30	35	40	45
ft²/acre					*ft³/acre*[b]					
70	107	116	132	141	143	73	78	95	107	110
85	113	122	139	149	144	73	82	102	118	119
100	106	119	140	150	148	83	94	113	130	135
"Increasing"	108	121	140	152	154	75	81	99	115	117
"Judgment"	106	120	136	149	153	76	87	108	122	124
55	...	138	148	152	147	...	...	...	...	...
115	...	132	146	164	159	...	...	...	...	...
130	...	129	144	165	165	...	...	...	...	...

[a] Plots thinned from above were omitted from these calculations.

[b] Inside bark, in trees $\geq$3.6 inches d.b.h. containing $\geq$two 63-inch bolts to a 3-inch top d.i.b.

Table 26.—*Periodic annual growth of sawtimber (Doyle)*

Thinning treatment	Good sites, ages				Medium sites, ages			
	30-35	35-40	40-45	30-45	30-35	35-40	40-45	30-45
ft²/acre				*fbm/acre*[a]				
70	954	916	857	909	217	577	479	424
85	833	827	529	730	268	633	715	539
100	571	686	621	626	277	633	828	580
"Increasing"	907	923	945	925	307	601	689	532
"Judgment"[b]	840	937	1,029	935	271	688	743	567
55	939	893	659	830	....	....	....	....
115	684	927	653	755	....	....	....	....
130	717	910	711	779	....	....	....	....

[a] Trees $\geq$9.6 inches d.b.h. containing $\geq$ one 16-foot log to an 8-inch top d.o.b.

[b] "Judgment" treatment included thinning from above and below. In all other treatments in this table, thinning was always from below.

foot m.a.i. was declining. Apparently then, cubic-foot m.a.i. in periodically thinned stands culminates at about 45 years, slightly earlier on better sites, slightly later on medium sites; however, at least one more regular inventory will be needed to confirm this trend. On good-site original thin-from-below plots, m.a.i. at 45 years was about 148 ft^3/acre; on supplementary plots, m.a.i. was 157 ft^3/acre; and on medium-site thin-from-below plots, m.a.i. was 121 ft^3/acre.

Yield tables such as those in U.S. Department of Agriculture, Forest Service (1976) and Meyer (1942) clearly show that m.a.i. in fully stocked stands culminates at about age 35. This early culmination occurs because at age 35 natural mortality caused by crowding exceeds the rate of stand total growth. Thinning from below mostly prevents crowding-induced mortality. So, we must expect culmination of m.a.i. to occur later in managed stands than it does in unmanaged. Culmination occurs as a plateau, not a sharp peak.

Board-Foot Growth and Yield

Standing Volumes.—Standing sawtimber volume in board feet (Doyle), all treatments combined, averaged:

	Medium sites	Good sites	Supplementary
30 years	224	1,882	3,978
35 years	1,386	5,396	7,417
40 years	4,095	8,911	10,974
45 years	7,108	11,450	12,083

Standing sawtimber volume on good-site original plots (fig. 6) was significantly greater when reckoned in Doyle rule from age 35 onward in the 70-ft^2 than in the 100-ft^2 treatment and from age 40 onward in the 70-ft^2 than in the 85-ft^2 treatment, because: (1) stem diameter growth is usually more rapid in heavily thinned stands than in those lightly thinned; (2) some trees in lightly thinned stands had not yet attained sawtimber size, even by age 45; and (3) the Doyle rule assigns disproportionately smaller volumes to small-diameter logs than to large-diameter logs.

Good-site original plots thinned from below to "increasing" basal area contained as much standing volume in board feet (Doyle) as the 70-ft^2 plots had at 30, 35, and 40 years; at 45 years "increasing" plots contained the greatest standing volume of any treatment (14.2 M bm), original or supplementary. The "judgment" treatment surpassed the 100 ft^2 treatment at age 35, equaled the 85-ft^2 treatment at age 40, and rivaled the "increasing" treatment at age 45.

In supplementary plots, standing board-foot volume (Doyle) differed little between treatments (fig. 7). When volumes were reckoned by the International ¼-inch rule, however, the 115-ft^2 and 130-ft^2 stands contained 3 to 5 M bm more volume than did the 55-ft^2 stands at 40 and 45 years. In contrast, for good-site plots, use of International ¼-inch rule instead of Doyle usually lessened the differences in standing volume between treatments.

No significant differences between treatments occurred in standing sawtimber volume (Doyle or Int. ¼) at any age on medium sites (fig. 8).

Thinning from below to an increasing basal area usually produced noticeably greater standing volumes (Doyle) than did thinning from above. These differences, significant on good sites but not on medium, diminished as the stands grew older. The differences were due in part to the bias inherent in the Doyle rule and in part to thinning method. For example, good-site stands thinned initially from above to "increasing" basal area had a mean d.b.h. of 10.6 inches at age 40, and 27 percent of the trees were below sawtimber size. Stands thinned always from below to "increasing" basal area on good sites had a mean d.b.h. of 13.0 inches at age 40, and every tree was in the 10-inch class or larger.

Total Yields.—On good-site original plots, sawtimber yield varied significantly with intensity of thinning, being low in the 100-ft^2, intermediate in the 85-ft^2, and high in the 70 ft^2 treatment. The "increasing" thin-from-below treatment produced board-foot yields somewhat greater than yields in the 70-ft^2 plots (Doyle and Int. ¼) (fig. 6). The "judgment" treatment surpassed the 100-ft^2 at age 35 and thereafter closely trailed the 70-ft^2 treatment.

Thinning to 55 ft^2 basal area resulted in greater sawtimber net yields (Doyle and Int. ¼) than did thinning to 115 ft^2 or 130 ft^2 (fig. 7). At 45 years, the 55 ft^2 stands had a net yield of 16,727 fbm/acre (Doyle) or 26,057 fbm/acre (Int. ¼). In short rotations on good sites, heavy thinning produced the largest net board-foot yields.

On medium sites from age 35 onward, the 70-ft^2 treatment yielded much less sawtimber than did any other treatment. Little difference was evident in board-foot yield among the 85-ft^2, 100-ft^2, "increasing," and "judgment" treatments.

As shown below, sawtimber yields of the 70-ft^2, 85-ft^2, and "increasing" treatments on good sites in this study are similar to those reported by Andrulot et al. (1972) for the "normal thinning" plots in the Urania study.

Age of stand	Urania study Total stand	Urania study Pine only	Crossett study Thinned from below to: 70 ft^2	Crossett study Thinned from below to: 85 ft^2	Crossett study Thinned from below to: "Incr."
years	*fbm/acre Int. ¼*				
30	7,594	7,441	4,960	6,263	5,980
35	13,185	13,003	14,173	14,520	14,923
40	18,777	18,575	20,587	20,843	21,810
45	23,369	23,155	26,233	24,427	28,243

Thirty-year yields exceeded those at Crossett, perhaps because a 5-inch top was used at Urania and an 8-inch top at Crossett, and because early thinning at Urania was more drastic than that at Crossett. From age 35 onward, Crossett yields exceeded Urania yields, in part because Crossett plots were kept free of hardwoods and in part because site index was about 5 feet higher at Crossett.

Periodic and Mean Annual Increment.—Periodic annual growth in sawtimber culminated between ages 35 and 40 at 858 fbm/acre in good-site original plots thinned from below (all treatments combined) and at 910 fbm/acre in supplementary plots. Periodic annual growth culminated at 954 fbm/acre in the 70-ft^2 and 833 in the 85-ft^2 between ages 30 and 35, and at 945 fbm between ages 40 and 45 in the "increasing" plots (table 26).

On good sites, culmination usually occurred earlier in the rotation and at a higher value in heavy thinning treatments and occurred later at a lower value in light thinning treatments. On medium sites, p.a.g. was 678 fbm/acre between ages 40 and 45 in plots thinned from below (all treatments combined); whether this rate was a maximum cannot be known before the next inventory. Culmination usually occurred later on medium sites than on good sites. Thinning intensity also affected results on medium sites, in a reverse of its effect on good sites. On medium sites, p.a.g. culminated at 828 fbm in the 100-ft^2, at 715 fbm in the 85-ft^2, at 689 fbm in the "increasing", and at 577 fbm in the 70-ft^2 treatment.

When these p.a.g. calculations were made with board feet Int. ¼, culmination occurred between ages 30 and 35 on good sites, in all thin-from-below treatments, original and supplementary. On medium sites, p.a.g. culminated between ages 40 and 45 in all thin-from-below plots except the 70

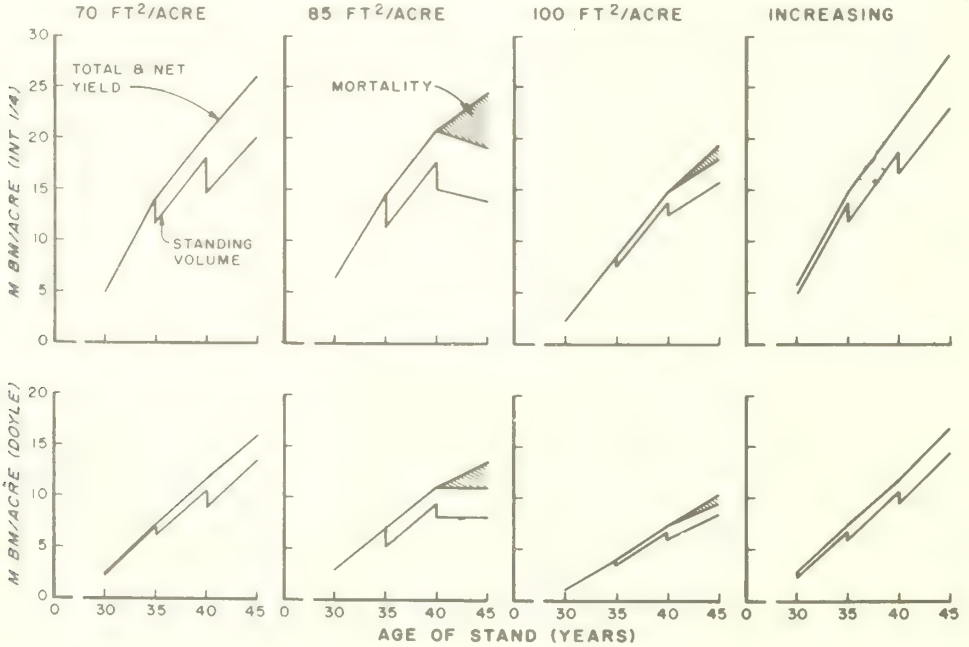

Figure 6.—Total sawtimber yield, net yield, cumulative natural mortality, standing volume, and volume harvested in thinning from below: 70-ft^2, 85-ft^2, 100-ft^2/acre, and "increasing" basal area on good sites.

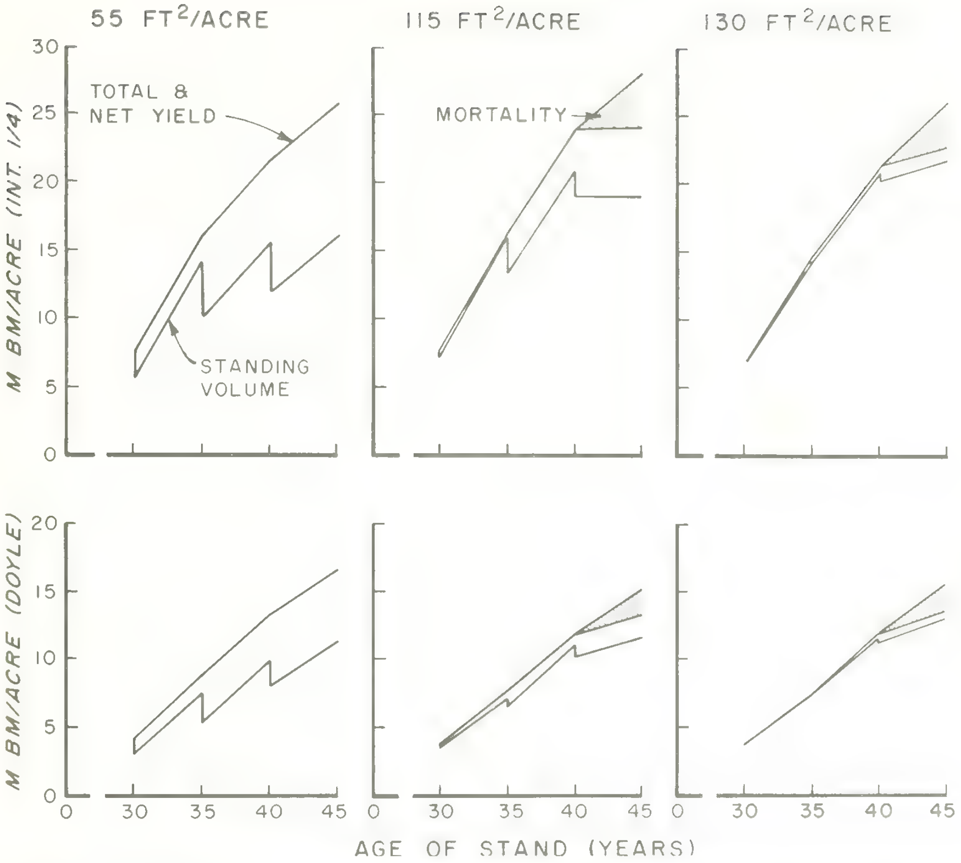

Figure 7.—Total sawtimber yield, net yield, cumulative natural mortality, standing volume, and volume harvested in thinning from below: 55-ft², 115-ft², and 130-ft²/acre on good sites.

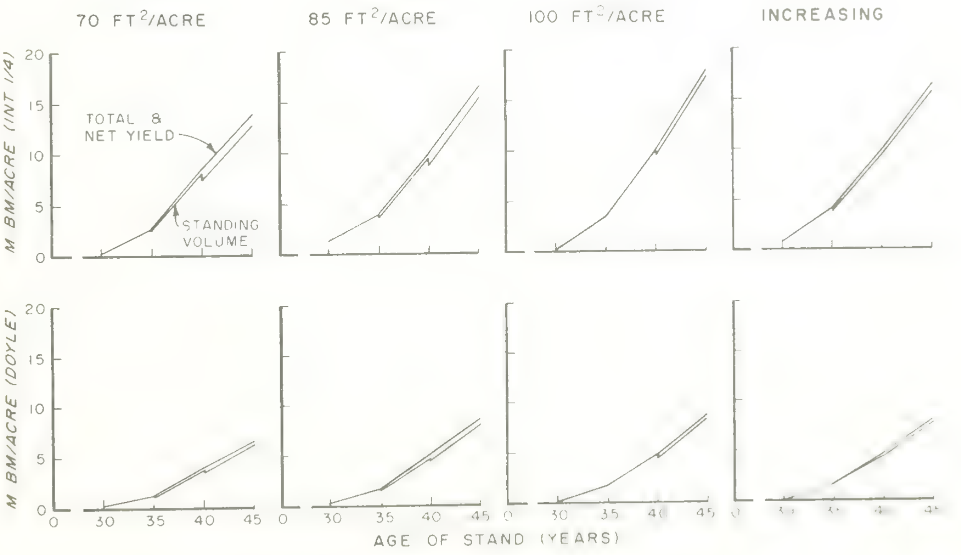

Figure 8.—Total and net sawtimber yield, standing volume and volume harvested, in thinning from below: 70-, 85-, 100-ft², and "increasing" basal area on medium sites.

ft² where it culminated between ages 35 and 40.

The p.a.g. values in table 26 cannot be compared directly with those found by Nelson et al. (1961) for the southeastern study, because the latter are in board feet Int. ¼. And even when table 26 is converted to Int. ¼, the p.a.g. values are much higher in the Crossett study than in the southeastern study.

Mean annual increment calculated in board feet Doyle (table 27) or Int. ¼ was still increasing rapidly at age 45 in all treatments on both sites.

Table 58 in U.S. Department of Agriculture, Forest Service (1976) shows that culmination in normal stands occurs at 70 years on site index 80, at 65 years on site index 90, and at 60 years on site index 100, for board feet (Doyle). Davis (1954), plotting data from Meyer's (1942) bulletin, indicated 44 years on site index 100, 45 years on site index 90, and 46 years on site index 80 for board feet Int. ¼ in unthinned fully stocked stands. Culmination can be expected to occur later in managed than in unmanaged stands.

This 41-year-old stand was thinned always from below to an increasing basal area. The increasing technique, one of several compared in this study, was the most effective at growing sawtimber in 45 years on good sites.

This 41-year-old stand on a medium site was thinned always from below to 100 ft²/acre. This thinning regime was the most effective of several compared for growing sawtimber on medium sites.

Table 27.—*Mean annual increment of sawtimber (Doyle)*

Thinning treatment	Good sites to age				Medium sites to age			
	30	35	40	45	30	35	40	45
ft²/acre	*fbm/acre*[a]							
70	78	203	292	355	5	35	103	145
85	96	201	280	307	17	53	126	191
100	36	112	184	233	5	44	117	196
"Increasing"	93	209	299	370	8	51	120	183
"Judgment"[b]	51	164	261	346	11	48	128	197
55	142	256	336	372	...	...	....	....
115	130	209	299	338	...	...	....	....
130	125	210	297	343	...	...	....	....

[a] Trees ≥9.6 inches d.b.h. containing ≥one 16-foot log to an 8-inch top d.o.b.

[b] "Judgment" treatment included thinning from above and below. In all other treatments in this table, thinning was always from below.

Table 28.—*Cubic-foot volumes of merchantable wood removed: unadjusted initial cut, adjusted initial cut,[a] and adjusted total harvests, and natural mortality in merchantable trees[b]*

Thinning level	Thinning method	Good sites: Initial Cut Unadj.	Good sites: Initial Cut Adj.	Good sites: Total through age 40 Unadj.	Good sites: Total through age 40 Adj.	Good sites: Mortality ages 30-45	Medium sites: Initial Cut Unadj.	Medium sites: Initial Cut Adj.	Medium sites: Total through age 40 Unadj.	Medium sites: Total through age 40 Adj.	Medium sites: Mortality ages 30-45
ft²/acre		*ft³/acre*									
70	Above	1,061	793	3,630	3,362	0	642	522	2,302	2,182	0
	Below	767	779	3,133	3,145	0	392	520	2,195	2,323	29
85	Above	737	708	3,381	3,352	87	405	407	2,636	2,638	0
	Below	711	652	3,148	3,089	1,093	430	344	2,223	2,137	0
100	Above	630	483	2,987	2,840	572	285	164	1,889	1,768	34
	Below	328	525	2.619	2,816	480	209	223	2,304	2,318	40
"Incr."	Above	738	962	2,707	2,931	335	439	549	1,887	1,997	144
	Below	940	790	3,177	3,027	25	444	432	1,943	1,931	9
"Judg."	Both	508	730	2,747	2,971	264	455	542	2,500	2,587	0
55	Below	1,790	1,999	3,905	4.114	0	....	....	.....	.....	...
115	Below	891	875	2,719	2,703	1,146	....	....	.....	.....	...
130	Below	740	548	2,354	2,162	974	....	....	.....	.....	...

[a] Initial cuts were made at age 25 in the 55 ft², 115 ft², and 130 ft²/acre treatments. Initial cuts were made at age 20 in all other treatments, on both sites.

[b] Total removal = total thinnings + total mortality.

Cubic-Foot and Board-Foot Volumes in Intermediate Harvests

Table 28 shows total cubic-foot volume o merchantable wood harvested from age 2 through age 40 in original plots and from age 2 through age 40 in supplementary plots. Adjusted and unadjusted volumes in first thinnings are presented side by side, as are adjusted and unadjusted total thinnings through age 40. This arrangement shows the amount of the adjusted initial cut and how it affected total harvest. Total volume in natural mortality of merchantable trees is shown.

Total board-foot volumes (Doyle) harvested, ages 30-40, in good-site original thin-from-below plots ranged from less than 1 M bm in "judgment" plots through 1.4 M bm in 100-ft^2 to 2.9 M bm in 70-ft^2/acre plots. On medium-site thin-from-below plots, total cut, ages 30-40, averaged only 0.27 M bm; the only apparent effect of thinning level was that "judgment" thinning produced the least volume ($<$ 0.06 M bm). Thinning from above harvested only 58 percent of the harvest of thinning from below on good sites and 82 percent on medium. On supplementary plots, total harvests, ages 30-40, were 5.3 M bm in 55-ft^2, 1.6 M bm in 115-ft^2, and 0.5 M bm in 130-ft^2/acre plots. Here again, however, the bias inherent in the Doyle rule can lead to erroneous conclusions.

When board-foot volumes harvested were reckoned by Int. ¼ rule, the 70-ft^2 treatment produced the largest total cut (5.9 M bm) on good-site original plots, and the 85-ft^2 treatment produced the largest (1.1 M bm) on medium sites. On both sites, the smallest total harvests in thin-from-below plots were in the 100-ft^2 treatment: 2.2 M bm on good sites and 0.4 M on medium. On supplementary plots, total cuts ranged from 9.9 M bm on 55-ft^2 to 1.0 M bm on 130-ft^2/acre plots.

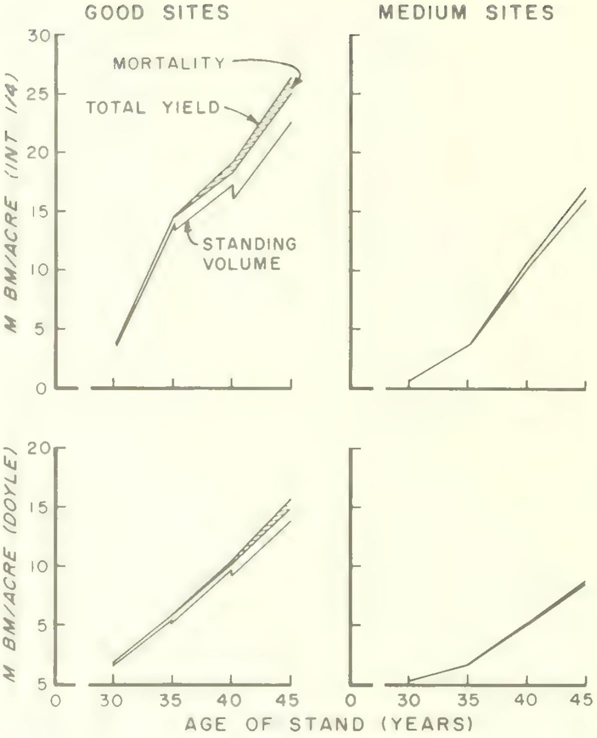

Figure 9.—Total and net sawtimber yield, and volume harvested in the "judgment" treatment on good and medium sites.

DISCUSSION

Each thinning treatment in this study represents a silvicultural alternative. The "judgment" treatment, however, is a special case. On both good and medium sites, yields in "judgment" plots compared favorably with yields of most other treatments (fig. 9). But this finding may be of little value to the average forest landowner. A team of four to six experienced workers acting together and without restrictions can thin as well as, and frequently better than, a single employee faithfully following one of the other eight thinning regimes. In reality, however, most timber marking is done not by a committee of experienced people, but by an individual often with limited experience and limited time to get the job done.

So, the treatment a landowner selects must depend on his objectives and circumstances; the site quality of the land; and the age, condition, and stand structure of his loblolly-shortleaf pine forest.

Management's primary aim may be growing sawtimber trees 9.6 inches d.b.h. and larger, in even-aged stands. Results of this study make a good case for initial heavy thinning from below, on good sites, to a basal area of 70 ft^2/acre at age 20 and then increasing the residual stand density by 5-ft^2 steps. The "increasing" treatment produced the best yield, and the 70-ft^2 the second best. If the landowner is trying to decide between the two, he may elect to be guided by the expected mean d.b.h. (fig. 1), the number of trees per acre (tables 3-7), and any restraints on rotation length peculiar to his ownership. These two treatments began alike. So, if the landowner selected either treatment, he could change to the other later. The 55-ft^2 treatment also produced large board-foot yields.

These three treatments share some advantages and liabilities: they involve a small investment in growing stock; they encourage rapid growth of trees to large sizes in short rotations; they involve heavy early thinnings and, therefore, relatively large early returns; and they encourage aggressive understory development and, so, require much weeding. The better the site and the more severe the thinning, the more urgent will be the need for understory control.

If the landowner's primary objective is to grow wood fiber, densities higher than these are indicated. In this study, the 130-ft^2 and the 115-ft^2 treatments produced the greatest total cubic-foot yields in the supplementary plots. The 100-ft^2 treatment produced the greatest total yield in the good-site original plots. Most of the reduction of net yield by the southern pine beetle occurred after age 40. So, if growing pulpwood is the sole objective, the landowner may prefer to do no thinning at all and to clearcut at 35 years, in view of the high costs of thinning and the small cut volumes for the 130-ft^2 and the 115-ft^2 treatments.

If the landowner's objective is to grow sawtimber on medium sites, the "increasing" treatment would be best. Thinning to 85 ft^2 or 100 ft^2 produced slightly greater yields at 40 and 45 years, but the "increasing" treatment involves a smaller investment in growing stock and a heavier early thinning.

If the aim of management is to grow pulpwood on medium sites, light thinning, or perhaps no thinning, is called for. Thinning from below to 100 ft^2 was the best pulpwood regime on medium sites in this study.

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Presents total and net yield, standing volume, volume harvested, and number of trees by d.b.h. class by 5-year periods, ages 20-45, in even-aged stands on two sites, repeatedly thinned to various densities. Cubic-foot volume to a 3-inch top is given for ages 20-45. Board-foot volume, Doyle and Int. ¼-inch, to an 8-inch top, is given for ages 30-45.

Additional keywords: *Pinus taeda* L., *P. echinata* Mill., stand structure, diameter distribution, stand density.

Conversion to Metric Units

1 inch	= 2.54 centimeters
1 foot	= 0.3048 meter
1 acre	= 0.4047 hectare
1 tree/acre	= 2.47 trees/hectare
1 cubic foot/acre	= 0.06997 cubic meters/hectare
1 square foot/acre	= 0.2296 square meter/hectare
1 board foot	= 0.005663 cubic meter
1 cubic foot	= 0.0283 cubic meter

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Predicting Field Performance of Slash Pine Families from Inoculated Greenhouse Seedlings

C. H. Walkinshaw, T. R. Dell, and S. D. Hubbard

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SUMMARY

Observations of new traits on seedlings inoculated in the greenhouse improved prediction of field resistance of slash pine families to fusiform rust threefold. Incidence of swellings, the sole predictor currently used, accounted for only 19 percent of the variation in the field rust index. A multiple regression equation that used proportion of smooth galls and incidence of disease symptoms without swelling accounted for 59 percent of the variation in field performance. Adding to that equation proportion of fat galls as a variable explained 62 percent of the variation. The three variables can be measured at a cost not appreciably higher than that of determining just incidence of swellings.

1980

Predicting Field Performance of Slash Pine Families from Inoculated Greenhouse Seedlings

C. H. Walkinshaw, T. R. Dell, and S. D. Hubbard

INTRODUCTION

Incidence of stem swellings on slash pines (*Pinus elliottii* var. *elliottii* Engelm.) inoculated with *Cronartium quercuum* Berk. Miyabe Shirai f. sp. *fusiforme* varies greatly by inoculum source (Snow and Kais 1970, Snow et al. 1975), inoculum density (Laird and Phelps 1975, Matthews et al. 1978), and age of seedlings (Wells and Dinus 1974). The variation may explain poor correlations between field and greenhouse tests (Wells and Dinus 1974).

Today, percentage of seedlings galled in the greenhouse is the only trait used to predict how seedlings will perform in the field. This trait is not always adequate, so improved greenhouse tests are needed. This paper reports usefulness of various traits for predicting performance of slash pine families that had been tested extensively in the field and differed widely in their field performance.

METHODS

Procedures of aeciospore collection and handling, oak inoculation, basidiospore harvest, pine inoculation (concentrated basidiospore spray system), and measurement of pine growth were according to Laird and Phelps (1975). Seed and field performance indices for 30 slash pine families were provided by R. E. Goddard of the University of Florida. Family identity was withheld until data were collected (the Florida family numbers are given in table 1).

Seeds for each of the 30 families were germinated and seedlings grown at the Resistance Screening Center near Asheville, North Carolina. Northern red oaks (*Quercus rubra* L.) were

Table 1.—*Actual and predicted field performance for slash pine families inoculated with* C. quercuum *f. sp.* fusiforme *at Resistance Screening Center.*

Pine family	1978 Rust evaluation index [a] Y	Predicted index [b] $\hat{Y}$
89-57	1.49	1.48
16-59	1.37	1.41
211-55	1.33	.73
3-56	1.31	1.04
293-55	1.25	1.19
187-57	.97	.33
246-55	.91	.33
317-56	.82	.21
261-55	.71	.30
130-60	.66	−.08
101-56	.48	.73
232-55	.31	−.22
116-56	.26	.38
237-55	.16	−.33
248-55	.13	.12
69-61	.09	−.05
259-55	.08	−.05
64-56	.07	.90
265-56	.05	.48
113-56	.01	.24
263-56	−.13	−.37
234-55	−.37	−.01
30-60	−.38	.15
122-61	−.48	−.07
163-56	−.62	−.66
30-62	−.62	−.46
178-58	−.64	−.36
51-57	−.70	−.37
298-55	−.72	−.01
160-57	−.75	−.12

[a] Families listed in decreasing order of performance. Values supplied by R. E. Goddard of the University of Florida. The field index is the average variation in standard deviations from test means, weighted by test severity. (Goddard, R. E., personal communication Nov. 9, 1979.)

[b] Calculated from $\hat{Y}$ = 5.47 +21.3 (*proportion symptoms but no swelling*) −3.16 (*proportion fat galls*) −3.06 (*proportion smooth galls*), where the three traits were determined on inoculated seedlings.

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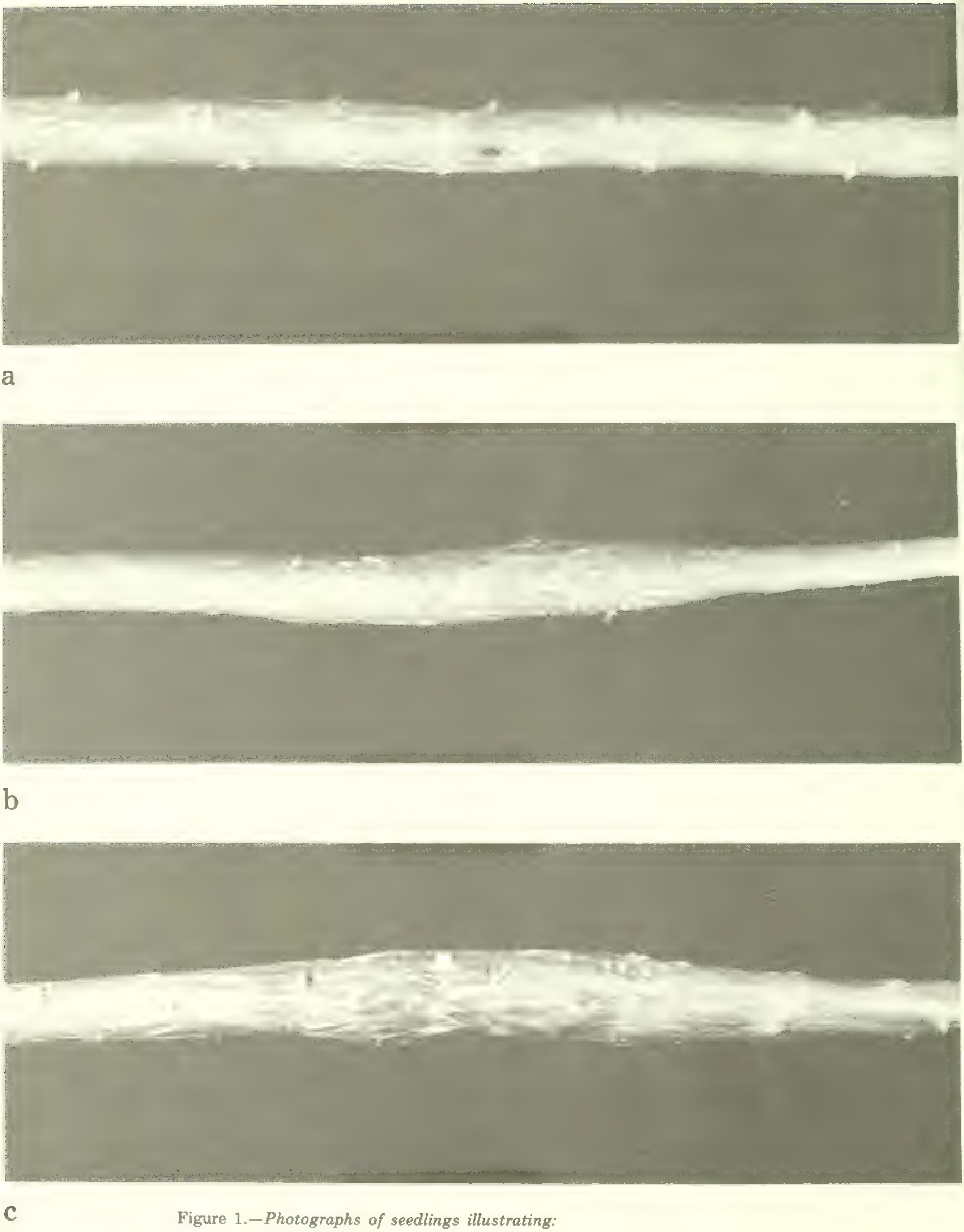

Figure 1.—*Photographs of seedlings illustrating:*
(*a*) *Symptoms but no swelling.*
(*b*) *Smooth gall (texture of gall approximates that of unaffected stem).*
(*c*) *Rough gall.*

inoculated with a composite of aeciospores from 30 individual galls from Nassau, Duval, Clay, and St. Johns counties in Florida. This composite's origin was the closest (80-120 km) in the Center's inventory to some of the field tests of the slash pine families. Density of basidiospores was adjusted to 20,000 ± 600 spores/ml (the Center's standard for slash pine tests).

Trays of 20 seedlings were inoculated and maintained in a nonsystematic design. Each of three replications was inoculated on a different day, and new spore suspensions from separate oak inoculations were used each day. For each replication, we planned to inoculate three trays of seedlings for each of 30 pine families. Poor seed germination left only two trays per replication for each of five families and one tray per replication for each of three families.

Observations and photographs were made 6 months after inoculation. We formulated 12 variables to be evaluated as predictors of the long-term field response to fusiform rust (Y). Names and explanations of variables are as follows:

proportion no symptoms—proportion of seedlings showing, when viewed by the unaided eye, neither localized bark discoloration nor swelling on the stem.

proportion symptoms but no swelling—proportion of seedlings showing some symptom of rust but no swelling or bumps on the stem (fig. 1a).

proportion with swellings—proportion of seedlings with swellings or bumps on the stem.

proportion fat galls—proportion of galled seedlings with stem swellings that increase stem circumference at the center of gall greater than 100 percent.

proportion smooth galls—proportion of galled seedlings that have majority of the gall surface with the same texture as the unaffected stem tissue above or below the swelling (fig. 1b).

proportion with reaction wood—proportion of galled seedlings that have reddish-brown necrotic areas in the pith and inner xylem that are visible when stems are cut in transverse sections. Presence was based on tissue exposed by five cuts through each gall.

average length of galls—the lengths (mm) of girdling or non-girdling galls were averaged for galled seedlings in each tray. For multiple galls, length of the longest discrete swelling was used.

greater than two shoots—proportion of seedlings with more than two adventitious shoots emerging at acute angles along the stem. Shoots emerging at right angles near the soil line were not counted.

greater than five shoots—proportion of seedlings with more than five adventitious shoots.

height ratio—ratio of average height of seedlings with any rust symptom over the corresponding average for seedlings with no symptoms.

weight ratio—ratio of average weight of seedlings with any rust symptom over the corresponding average for seedlings with no symptoms.

disease severity index—average disease severity index where,

1 = no symptoms
2 = bark disruption or discoloration only
3 = bump only or nongirdling gall (one-sided), rough or smooth texture
4 = fusiform gall girdles stem; gall texture is rough or discolored (fig. 1c)
5 = smooth, typical fat girdling gall, most severe disease.

Y—variable to be predicted is the 1978 rust evaluation index furnished by R. E. Goddard (see table 1).

The cost of measuring traits was calculated from hourly records and earning rates for two kinds of observers. Determination of disease severity, gall length, and reaction zone required a scientist; other traits were measured by technicians.

Multiple linear regression relationships for the 12 explanatory variables and the response variable were investigated with an all-possible-regressions approach that used the REX program (Grosenbaugh 1967) and smallest mean-squared residual selection criterion.

RESULTS AND DISCUSSION

Summary statistics for the variables are in table 2. The simple correlation of *proportion with swellings* and Y is $-.44$, so only 19 percent of the variation in field index is explained by the variable that has been the sole predictor in most previous work. Comparison of the simple correlation between Y and each of the predictor variables indicates the *proportion with reaction wood* explains more of the variation in Y than does any other variable. *Proportion with reaction wood* was also included with *proportion symptoms but no swelling* in the best two-variable equation. However, the two-variable equation with *proportion symptoms but no swelling* and *proportion smooth galls* was nearly as good, and the cost of measuring the two variables was less than one-third that of measuring the variables for the combination that includes *proportion with reaction wood.* The equation below explained 59 percent of the variance in the field rust value.

$$\hat{Y} = 4.06 + 23.6\ (\textit{proportion symptoms but no swelling}) - 4.78\ (\textit{proportion smooth galls})$$

Adding certain other variables did not improve the equations enough to justify added observation costs. For example, if *proportion with reaction wood* is included as a third variable, 64 percent of the variance is explained, but the cost of observation is increased five-fold and safety becomes a problem because the seedling stem must be cut. *Proportion fat galls,* however, can be observed at essentially no extra cost. When *proportion fat galls* is included, all basic information from the first five characters listed in table 2 is considered. *Proportion fat galls* was the best of the low-cost single variables. So, the following equation which explains 62 percent of the variation was selected:

$$\hat{Y} = 5.47 + 21.3\ (\textit{proportion symptoms but no swelling}) - 3.16\ (\textit{proportion fat galls}) - 3.06\ (\textit{proportion smooth galls}).$$

Predicted field performances based on the three-variable equation are in table 1. The maximum value would be 26.77, which would be approached as *proportion symptoms but no swelling* approaches 1, and *proportion fat galls* and *proportion smooth galls* approach zero. High rust resistance then is associated with seedlings showing symptoms but few developing swellings that are fat or smooth. The minimum limit would be −.75, when every seedling has a smooth, fat gall. We did have a −.66 for family 163-56, which had 0 for *proportion symptoms but no swelling,* 0.99 for *proportion fat galls,* and 0.98 for *proportion smooth galls.*

The 30 slash pine families selected for this study ranged from resistant to highly susceptible. Since the most resistant family had with the three-variable equation, a $\hat{Y}$ of 1.48, improvement in resistance can be made without approaching the theoretical upper limit ($\hat{Y} = 26.77$). We were far from the condition in which every seedling shows signs of having gotten the disease but every one recovers with no swelling. On the other hand, $\hat{Y}$ for the poorest performer approached the lower limit of −.75. Test conditions were ideal for the fungus and maximum pressure was exerted on families.

Field resistance of slash pine to fusiform rust can be predicted more accurately by observing traits on inoculated seedlings other than just stem swellings. The selected new traits are easy to observe, and the total cost is about the same as the cost of observing only stem swellings. Under operational conditions at the Resistance Screening Center, plant trays would be observed once by a technician. The skill required is the same as needed to identify stem swellings.

Application of our results requires that an observation sequence such as that depicted in figure 2 be used. A separate record of the information on each seedling can be maintained, or the totals can simply be accumulated in five counters. It seems that the observation sequence is most efficiently carried out by one person accumulating the five specified totals. If no seedlings have rust symptoms, the predicted value for the equation is not defined. This outcome would indicate that the greenhouse test conditions were not sufficiently conducive to rust development for a valid test.

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Table 2.—*Summary statistics for the 12 potential predictor variables and the response variable.*

Variable	Mean	Standard deviation	Minimum	Maximum	Simple correlation[a] with Y	Relative cost each separately[b]
proportion no symptoms	.124	.062	.046	.290	.34	1.0
proportion symptoms no swelling	.014	.017	.000	.086	.55	1.0
proportion with swellings	.861	.069	.689	.954	−.44	1.0
proportion fat galls	.911	.058	.754	1.000	−.61	1.0
proportion smooth galls	.872	.080	.609	.979	−.52	1.0
disease severity index	4.252	.139	3.495	4.788	−.60	2.5
average length of galls (mm)	38.042	4.777	29.529	47.605	−.44	8.5
proportion with reaction wood	.144	.077	.055	.318	.64	5.3
greater than 2 shoots	.301	.110	.099	.492	−.50	1.0
greater than 5 shoots	.022	.024	.000	.095	−.16	1.0
height ratio	.981	.085	.842	1.235	.11	1.25
weight ratio	1.458	.578	1.010	3.176	−.22	2.25
Y	.235	.710	−.75	1.49	. . .	Not determined

[a] If r exceeds .36 (absolute value) the simple linear regression relating the explanatory variables to Y is significant (α = .05).

[b] Costs of observations for combinations of traits are not necessarily additive. For example, the relative cost of observing all the first five traits is not appreciably greater than one alone.

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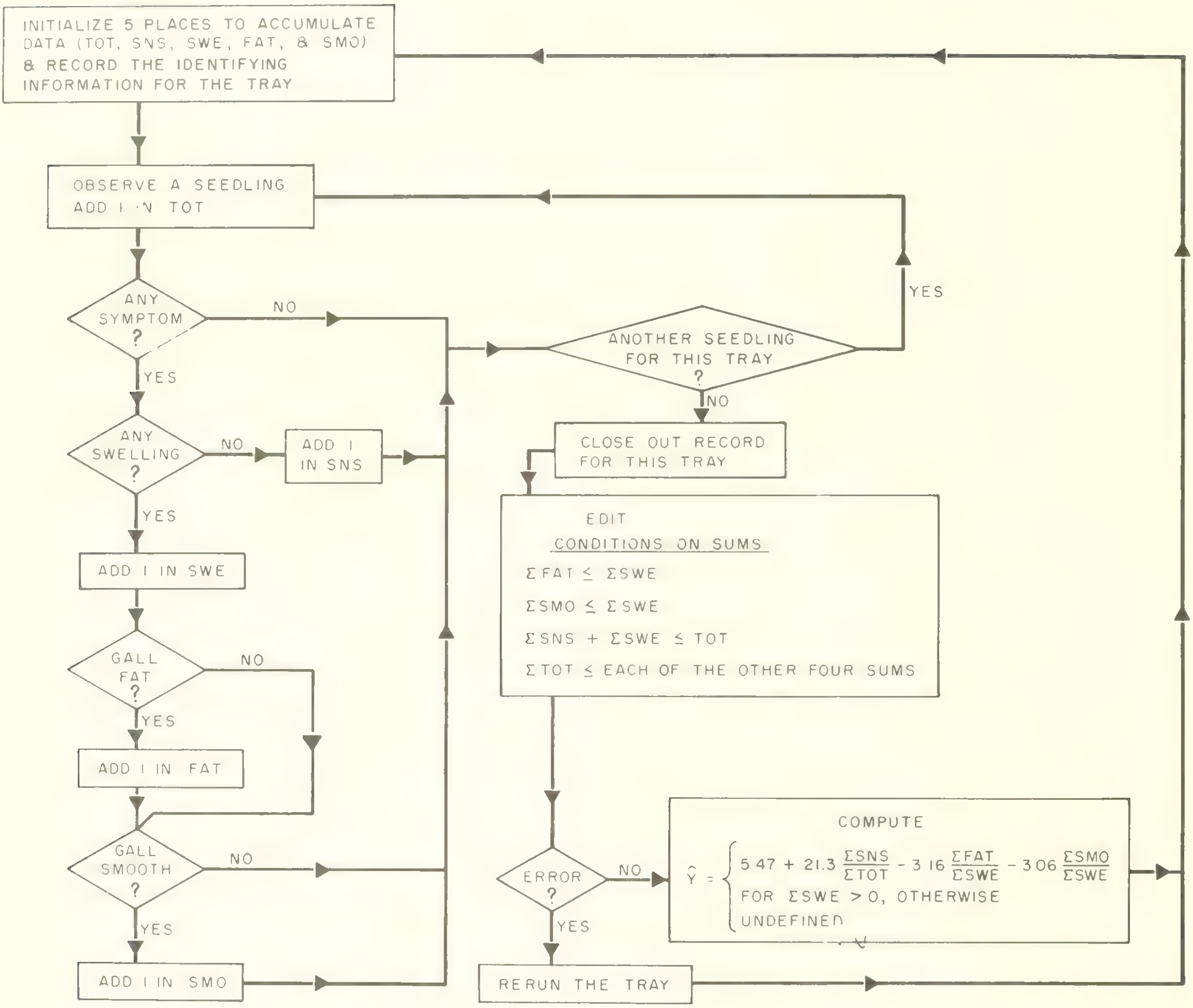
INITIALIZE 5 PLACES TO ACCUMULATE DATA (TOT, SNS, SWE, FAT, & SMO) & RECORD THE IDENTIFYING INFORMATION FOR THE TRAY
OBSERVE A SEEDLING ADD 1 IN TOT
ANY SYMPTOM ?
NO
YES
ANY SWELLING ?
NO
ADD 1 IN SNS
YES
ADD 1 IN SWE
GALL FAT ?
NO
YES
ADD 1 IN FAT
GALL SMOOTH ?
NO
YES
ADD 1 IN SMO
ANOTHER SEEDLING FOR THIS TRAY ?
YES
NO
CLOSE OUT RECORD FOR THIS TRAY
EDIT
CONDITIONS ON SUMS
ΣFAT ≤ ΣSWE
ΣSMO ≤ ΣSWE
ΣSNS + ΣSWE ≤ TOT
ΣTOT ≤ EACH OF THE OTHER FOUR SUMS
ERROR ?
NO
YES
COMPUTE
Ŷ = 5.47 + 21.3 ΣSNS/ΣTOT - 3.16 ΣFAT/ΣSWE - 3.06 ΣSMO/ΣSWE FOR ΣSWE > 0, OTHERWISE UNDEFINED
RERUN THE TRAY

TOT = TOTAL SEEDLINGS
SNS = SYMPTOMS BUT NO SWELLING
SWE = SWELLINGS
FAT = FAT GALLS
SMO = SMOOTH GALLS
Σ IMPLIES SUMMATION OR THE FINAL COUNT FOR THE TRAY

Figure 2.—*Flow chart for observation sequence in greenhouse tests for fusiform rust resistance.*

WALKINSHAW, C. H., T. R. DELL, and S. D. HUBBARD. 1980. Predicting field performance of slash pine families from inoculated greenhouse seedlings. U.S. Dep. Agric. For. Serv. Res. Pap. SO-160, 6 p. South. For. Exp. Stn. New Orleans, La.

Twelve traits for predicting field resistance of slash pine to fusiform rust have been described. Three of these combined greatly improve greenhouse prediction tests.

Additional keywords: *Cronartium quercuum* f. sp. fusiforme, Pinus elliottii var. elliottii, fusiform rust.

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Seasonality of Nutrient Quality and Digestibility Of Three Southern Deer Browse Species

Robert M. Blair, Henry L. Short, Leonard F. Burkart,
Austin Harrell, and James B. Whelan

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SUMMARY

Value of three browse species for deer was studied on a seasonal basis. Findings show seasonal variations in nutrient quality and metabolic usefulness of leaves and twig tips are closely associated with plant growth and tissue maturation. During rapid spring growth, leaves and twigs were most succulent and their dry matter fraction was highest in nutrition and digestibility. As twig growth slowed in early summer, fiber deposition increased in maturing tissues and quality and digestibility declined. These relationships were more pronounced in twigs than in leaves. Throughout the year leaves generally were significantly higher in nutrient quality and digestibility than twig tips. Evergreen leaves maintained a relatively high quality and metabolic usefulness in autumn and winter while the abscissed leaves of deciduous species, like twigs, were low in digestibility and were a poor source of nutrition.

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Austin Harrell, and James B. Whelan

INTRODUCTION

Changes throughout the year in the nutrient composition and dry-matter digestibility of leaves and twig tips from three deer browse species are assessed in this paper. The browse species studied are common to the loblolly *(Pinus taeda* L.)-shortleaf pine *(Pinus echinata* Mill.) forest type and are: Flowering dogwood *(Cornus florida* L.), Common sassafras *(Sassafras albidum* [Nutt.] Nees), and Japanese honeysuckle *(Lonicera japonica* Thumb.).

All tissue samples were collected from plants growing on open areas devoid of an overstory for several years.

Seasonal trends or variations in the nutrient composition and digestibility of southern browses are closely associated with growth physiology (Blair and Halls 1968). These relationships are evident particularly in twig tissues whereas the seasonality of nutrient levels in leaves is often much less pronounced. Twig elongation and leaf development proceed rapidly for a short period in the spring and by early summer, about June, growth on most species is essentially completed. Additional growth flushes occur on some species following summer rains and on some evergreen browses during warm periods in the winter. As twig growth slows with increasing summer temperatures, cell walls thicken and lignin and cellulose deposition intensifies (Kozlowski 1971). Cellular protoplasm (Wort 1962) and tissue succulence decline. Concurrent with these physiological changes is a decline in the nutrient quality and digestibility of browse tissues, particularly twigs.

The study was conducted during 1973 on the Stephen F. Austin Experimental Forest near Nacogdoches, Texas. The terrain is relatively flat and soils are fine sandy loam with heavy clay subsoils. Annual precipitation averages 46 inches with a mean frost-free period of about 236 days. Soils are acid in reaction and low in organic matter and plant nutrients, particularly phosphorus.

METHODS

Tissue samples for dogwood and honeysuckle were collected from plants growing in a plantation. Sassafras collections were from natural stock growing near the planted stock. The two plantations and natural area were divided into segments or plots, each containing a sufficient number of plants for a full year's collection of tissue. Three plots were then randomly drawn from each species area to provide 3 replications of tissue for a given collection period. Dogwood plants were about 10 years old and ranged from about 5 to 7 feet in height. The honeysuckle plantation was 5 years old with plants in rows growing on woven wire trellises 36 inches high. Natural sassafras stock ranged from 3 to 6 feet in height.

Plant Tissue Collection

Plant tissues were collected 7 times during a 1-year period: At mid-month in April and May to reflect the spring period of rapid and succulent plant growth; in June, August, and September, the period of heat stress on both plants and deer;

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in October, the period immediately preceding leaf abscission on deciduous browses; and in January, the period of general plant dormancy and minimal forage availability and nutrient stress.

The terminal 2 inches of twigs from dogwood and sassafras and the terminal 6 inches of leaders from honeysuckle and the attached leaves were collected for analyses. Tissues were removed only once from any plant and all samples were confined within the 5-foot deer feeding zone. Each sample was generally a composite of several proximate plants. Immediately prior to autumnal leaf abscission light netting was placed around the canopy of sample plants of dogwood and sassafras to retain a winter sample of leaves. After leaves abscissed they were spread out to weather in shallow wire baskets situated 2 inches off the ground.

All samples were collected between 10:00 a.m. and 2:00 p.m. to minimize the diurnal fluctuation in sugar content of cell sap. Leaves were removed from stem fractions, and, except for winter collection, all excised samples were immediately sealed in moisture-tight containers and placed on ice to retard enzymatic degradation. Periodically during each collection day samples were transported to the laboratory, weighed, and placed in a forced draft drying oven. Tissues were dried to constant weight at 55 °C. During the spring period additional samples of leaves and twigs of each species were collected and dried at 100 °C. The percentage decrease in dry matter between drying at 55 ° and 100 ° was used to correct all samples during the year to an oven-dry base of 100 °.

Nutrient And Digestibility Analyses

Dried tissues were ground through a 1 mm screen in a Wiley mill and analyzed for crude protein, phosophorus, calcium, and crude fat by methods of the Association of Official Agricultural Chemists (1965). Neutral detergent fiber or cell wall constituents (CWC), acid detergent fiber (ADF), and acid detergent lignin (ADL) were determined by the procedures of Goering and Van Soest (1970). Cell solubles (CS) were estimated as the difference between the total dry matter and CWC, hemicellulose as the difference between CWC and ADF, and cellulose as the difference between ADF and ADL. Caloric values, expressed as gross energy (GE), were assayed by oxygen bomb calorimetry. Apparent digestible energy (ADE) values were estimated from gross energy values using the regression $Y = -0.713 + 0.911X$ where $Y = \%$ ADE and $X = \%$ dry-matter digestibility (Robbins et al. 1975). Apparent digestible energy was expressed as a caloric value by the equation, $\text{cal/gm} = \text{GE} \times \%\ \text{ADE}/100$.

In vitro dry-matter digestibility was determined by the two-stage method of Tilley and Terry (1963) as modified by Palmer et al. (1976) and Carlile (1978). The source of inoculum for *in vitro* digestions was a rumen-fistulated Hereford steer maintained on a 50:50 concentrate: roughage diet. *In vivo* dry-matter digestibility (IVDMD) values for deer were estimated from the *in vitro* determinations using the prediction equation $Y = a + bX$, where Y = percent *in vivo* dry-matter digestibility and X = percent *in vitro* digestibility. Each set of *in vitro* determinations conducted in the laboratory requires development of a corresponding prediction equation according to precedures described by Palmer et al. (1976).

Statistical Treatment

Composition and digestibility values were subjected to one-way variance analyses to determine differences between each plant fraction from early spring to winter, differences between plant fractions at each collection period, and differences between species for an individual plant part at each time period (0.05 level of significance). Duncan's (1955) multiple range test was employed to further define time, species and plant-part differences in nutrient quality and dry-matter digestibility. Bivariate correlation matrices of cellular and cell wall constituents and digestibility were developed for both leaves and stems at each of 4 seasons. Species were composited for each plant part and the 7 time periods were grouped appropriately to approximate the 4 seasons.

LEAF ANALYSES

Nutrient Composition

Spring.—In April and May, when twigs were elongating rapidly and leaf and stem tissues were highly succulent, leaves contained the highest levels of crude protein, phosphorus, apparent digestible energy (ADE) and highly digestible cell solubles (table 1). The cell soluble fraction includes lipids, sugars, organic acids, nonprotein nitrogen, pectins, soluble protein, and other water soluble matter. Levels of the poorly or nondigestible fibrous fractions, consisting of cell wall constituents (CWC), acid detergent fiber (ADF), acid detergent lignin (ADL), and cellulose were lowest. Protein and phosphorus levels declined significantly in all species from April to May. ADE, cell solubles, and fibrous fractions generally changed little.

During spring growth, leaves of Japanese honeysuckle contained higher levels of protein and phosphorus than leaves of flowering dogwood (table 2). Sassafras tended to be in the median range. Honeysuckle and dogwood contained a similar level of ADE, which was higher than the content in sassafras. Leaves of dogwood were significantly higher in cell solubles and generally lower in fibrous cell wall fractions than those of sassafras and honeysuckle.

Summer - Autumn— As growth activity slowed with the onset of higher ambient temperatures in early June, trends in cell and cell wall constituents of leaves varied somewhat by species. On the average, protein, phosphorus, ADE, and cell soluble levels declined by mid-June and remained low through summer and autumn. Fibrous cell wall constituents increased as leaves matured. High levels of protein were significantly associated with high levels of phosphorus in spring and summer. Both protein and phosphorus generally were negatively correlated with the dry matter content of leaf tissues from spring through autumn. Significant correlations associated with these constituents ranged from $r = -0.60$ to $r = -0.93$. High levels of calcium were associated with low levels of protein and cell wall constituents at all seasons.

By mid-June the average protein content of all species was down to 63 percent of the maximum recorded during rapid growth activity in April (fig. 1). Phosphorus averaged only 51 percent of the April maximum. As leaves matured they maintained relatively high levels of ADE and highly digestible cell solubles. By June the average ADE level was 81 percent of the April maximum and it remained high throughout the summer and autumn. Cell soluble content dropped only 8 percentage units to 92 percent of the early spring high and the average content varied little during summer and autumn.

Leaves of all species had attained or were approaching their maximum level of CWC, ADF, ADL, and cellulose by June (fig. 1). Even at maximum levels fiber constituents of leaves remained relatively low. During the summer and autumn dogwood leaves were significantly lower in CWC, ADF and ADL than leaves of honeysuckle or sassafras (tables 1 and 2). CWC ranged from a low of 19.5 percent in flowering dogwood leaves to a high of 38.7 percent in Japanese honeysuckle. ADF ranged from a low of 17.9 percent to 30.4 percent in these respective species and nondigestible ADL varied from 4.4 percent in dogwood to 13.9 percent in sassafras.

Dogwood leaves were relatively high in calcium throughout the year compared to leaves of sassafras or honeysuckle. In dogwood leaves calcium ranged from a spring low of 1.45 percent of the dry matter to a summer-autumn high of 3.13 percent.

Winter.—Crude protein, phosphorus, ADE, cell solubles and calcium levels were generally significantly less in the abscissed and weathered leaves than in living leaf tissues of flowering dogwood and sassafras. The content of CWC, ADF, ADL, and cellulose was at the maximum level recorded throughout the year (table 1). Crude protein in the fallen leaves of dogwood and sassafras averaged only 37 percent of the maximum recorded during spring growth activity. Phosphorus averaged only 35 percent of the spring high and ADE was 56 percent. Abscissed leaves of dogwood were high in cell solubles and the January content was 92 percent of the maximum level in April. The January level of CS in sassafras leaves was only 67 percent of the spring high.

The evergreen leaves of Japanese honeysuckle varied little in content of crude protein and phosphorus from mid-summer to January. The protein level was down to 46 percent of the April maximum and the phosphorus content was only 30 percent of the recorded high in spring. Readily digestible cell solubles also remained rather constant during summer and autumn but the content increased significantly in winter leaves. The winter level was 95 percent of the maximum content in spring. New growth is sporadically stimulated on honeysuckle during warm periods throughout the winter (Halls and Alcaniz 1965). The content of CWC, ADF, and ADL was significantly lower in winter leaves of honeysuckle as compared to the hot summer period when fiber levels were maximum. January levels were about 81 percent of the maximum content recorded in August.

Table 1. — *Seasonality of nutrient composition and digestibility of leaves from 3 species collected in east Texas*

Chemical constituent	Species	Month collected						
		April	May	June	August	September	October	January
Dry matter[1]	COFL[4]	31.0 f[5]	34.7 e	38.5 d	40.2 cd	41.8 bc	43.4 b	85.5 a
	SAAL	25.4 e	31.0 d	33.9 c	39.7 b	40.5 b	38.1 b	85.6 a
	LOJA	24.9 c	26.7 c	32.1 b	36.2 a	37.3 a	38.7 a	37.4 a
Crude protein[2]	COFL	13.7 a	10.0 b	8.3 c	7.7 cd	7.5 cd	7.2 d	5.3 e
	SAAL	21.0 a	13.3 b	13.1 b	11.9 bc	12.1 bc	11.0 c	7.5 d
	LOJA	20.7 a	18.2 b	13.5 c	9.9 d	10.0 d	10.1 d	9.5 d
Phosphorus[2]	COFL	0.22 a	0.14 b	0.14 b	0.12 bc	0.12 bc	0.13 bc	0.09 c
	SAAL	0.30 a	0.15 b	0.15 b	0.13 b	0.14 b	0.14 b	0.09 c
	LOJA	0.43 a	0.36 b	0.19 c	0.15 cd	0.11 d	0.11 d	0.13 cd
Calcium[2]	COFL	1.45 c	1.74 c	1.87 c	3.13 a	3.07 a	3.10 a	2.42 b
	SAAL	0.60 e	0.76 d	0.76 d	1.00 c	1.21 b	1.34 a	1.19 b
	LOJA	0.36 e	0.38 e	0.68 d	1.00 c	1.18 b	1.32 ab	1.45 a
Crude fat[2]	COFL	4.4 d	4.1 d	6.7 c	10.1 b	9.9 b	13.0 a	12.9 a
	SAAL	4.8 c	4.2 c	6.4 b	6.7 b	7.0 b	8.9 a	4.7 c
	LOJA	6.3 a	5.6 ab	6.6 a	2.8 c	4.6 b	5.9 ab	4.4 b
Cell solubles[2]	COFL	82.5 a	82.2 a	78.6 c	80.5 b	78.0 c	79.4 bc	75.8 d
	SAAL	71.4 a	70.7 a	64.3 b	63.6 b	62.4 b	62.3 b	47.7 c
	LOJA	72.1 a	72.0 a	64.1 b	61.3 b	61.7 b	64.3 b	68.4 a
CWC[2]	COFL	17.5 d	17.8 d	21.4 b	19.5 c	22.0 b	20.6 bc	24.2 a
	SAAL	28.6 c	29.3 c	35.7 b	36.4 b	37.6 b	37.7 b	52.3 a
	LOJA	27.9 b	28.4 b	35.9 a	38.7 a	38.3 a	35.7 a	31.6 b
ADF[2]	COFL	15.2 d	15.6 d	20.0 b	17.9 c	20.4 b	19.0 bc	30.0 a
	SAAL	21.3 c	24.4 b	24.9 b	25.3 b	23.2 c	25.1 b	52.7 a
	LOJA	22.1 d	22.4 d	28.8 ab	29.5 a	30.4 a	27.6 b	24.4 c
ADL[2]	COFL	4.8 b	4.7 b	4.9 b	4.4 b	4.4 b	4.1 b	10.5 a
	SAAL	11.1 c	12.0 bc	13.2 bc	13.9 b	11.5 bc	12.9 bc	33.6 a
	LOJA	6.4 c	7.4 c	11.5 a	12.2 a	12.4 a	11.4 a	9.9 b
Hemicellulose[2]	COFL	2.3 a	2.3 a	1.4 a	1.6 a	1.6 a	1.6 a	0 b
	SAAL	7.4 c	4.9 d	10.8 b	11.2 b	14.4 a	12.6 ab	0.2 e
	LOJA	5.8 a	5.7 a	7.1 a	9.2 a	7.9 a	8.1 a	7.2 a
Cellulose[2]	COFL	10.4 d	10.9 d	15.1 bc	13.5 c	16.0 b	14.9 bc	19.5 a
	SAAL	10.1 b	12.3 b	11.7 b	11.4 b	11.8 b	12.2 b	19.1 a
	LOJA	15.7 bc	15.0 c	17.3 ab	17.3 ab	18.0 a	16.5 abc	14.5 c
GE[3]	COFL	4730 a	4731 a	4717 a	4685 a	4733 a	4656 a	4605 a
	SAAL	5133 a	5137 a	5126 a	5143 a	5148 a	5117 a	4509 b
	LOJA	5063 a	5023 ab	4987 ab	4773 c	4878 bc	4952 ab	4942 ab
ADE[3]	COFL	3046 a	3004 ab	2855 c	2887 bc	2813 c	2846 c	2126 d
	SAAL	3036 a	2870 ab	2707 bc	2721 bc	2626 c	2661 bc	1255 d
	LOJA	3290 a	3230 a	2984 bc	2842 c	2996 bc	2939 c	3133 ab

Table 1. — *Seasonality of nutrient composition and digestibility of leaves from 3 species collected in east Texas—Continued*

Chemical constituent	Species	Month collected						
		April	May	June	August	September	October	January
IVDMD[2]	COFL	65.7 a	64.8 ab	61.8 c	62.9 bc	60.7 c	62.4 c	47.3 d
	SAAL	60.4 a	57.1 ab	54.0 bc	54.1 bc	52.2 c	53.2 bc	28.8 d
	LOJA	66.3 a	65.6 ab	61.1 c	60.8 c	62.7 bc	60.6 c	64.7 ab

[1] Percent of fresh weight.

[2] Percent of dry matter.

[3] cal/gm.

[4] COFL = Cornus florida.
SAAL = Sassafras albidum.
LOJA = Lonicera japonica.

[5] Monthly values for each species (row) that are followed by a common letter do not differ significantly ($P > 0.05$).

Table 2. — *Monthly ranking[1] and statistical differences[2] of leaves of browse species for important nutrient attributes and dry-matter digestibility*

Month	Crude protein	Phosphorus	Calcium	ADE	Cell solubles	CWC	ADF	ADL	IVDMD
April	SAAL a	LOJA a	COFL a	LOJA a	COFL a	SAAL a	LOJA a	SAAL a	LOJA a
	LOJA a	SAAL b	SAAL b	COFL a	LOJA b	LOJA a	SAAL a	LOJA b	COFL a
	COFL b	COFL c	LOJA c	SAAL b	SAAL b	COFL b	COFL b	COFL b	SAAL b
May	LOJA a	LOJA a	COFL a	LOJA a	COFL a	SAAL a	SAAL a	SAAL a	LOJA a
	SAAL b	SAAL b	SAAL b	COFL a	LOJA b	LOJA a	LOJA a	LOJA b	COFL a
	COFL c	COFL b	LOJA c	SAAL b	SAAL b	COFL b	COFL b	COFL c	SAAL b
June	LOJA a	LOJA a	COFL a	LOJA a	COFL a	LOJA a	LOJA a	SAAL a	COFL a
	SAAL a	SAAL ab	SAAL b	COFL a	SAAL b	SAAL a	SAAL b	LOJA b	LOJA a
	COFL b	COFL b	LOJA b	SAAL b	LOJA b	COFL b	COFL c	COFL c	SAAL b
August	SAAL a	LOJA a	COFL a	COFL a	COFL a	LOJA a	LOJA a	SAAL a	COFL a
	LOJA b	SAAL a	SAAL b	LOJA a	SAAL b	SAAL a	SAAL b	LOJA b	LOJA a
	COFL c	COFL a	LOJA b	SAAL b	LOJA b	COFL b	COFL c	COFL c	SAAL b
September	SAAL a	SAAL a	COFL a	LOJA a	COFL a	LOJA a	LOJA a	LOJA a	LOJA a
	LOJA b	COFL a	SAAL b	COFL a	SAAL b	SAAL a	SAAL b	SAAL a	COFL a
	COFL c	LOJA a	LOJA b	SAAL b	LOJA b	COFL b	COFL c	COFL b	SAAL b
October	SAAL a	SAAL a	COFL a	LOJA a	COFL a	SAAL a	LOJA a	SAAL a	COFL a
	LOJA a	COFL a	SAAL b	COFL a	LOJA b	LOJA a	SAAL a	LOJA b	LOJA a
	COFL b	LOJA a	LOJA b	SAAL b	SAAL b	COFL b	COFL b	COFL c	SAAL b
January	LOJA a	LOJA a	COFL a	LOJA a	COFL a	SAAL a	SAAL a	SAAL a	LOJA a
	SAAL b	COFL a	LOJA b	COFL b	LOJA b	LOJA b	COFL b	COFL b	COFL b
	COFL c	SAAL a	SAAL b	SAAL c	SAAL c	COFL c	LOJA c	LOJA b	SAAL c

[1] Species ranked by descending order of magnitude for each specific nutrient attribute, based on values given in table 1

[2] Species within a monthly group for each chemical constituent that are followed by a common letter are not statistically different ($P > 0.05$).

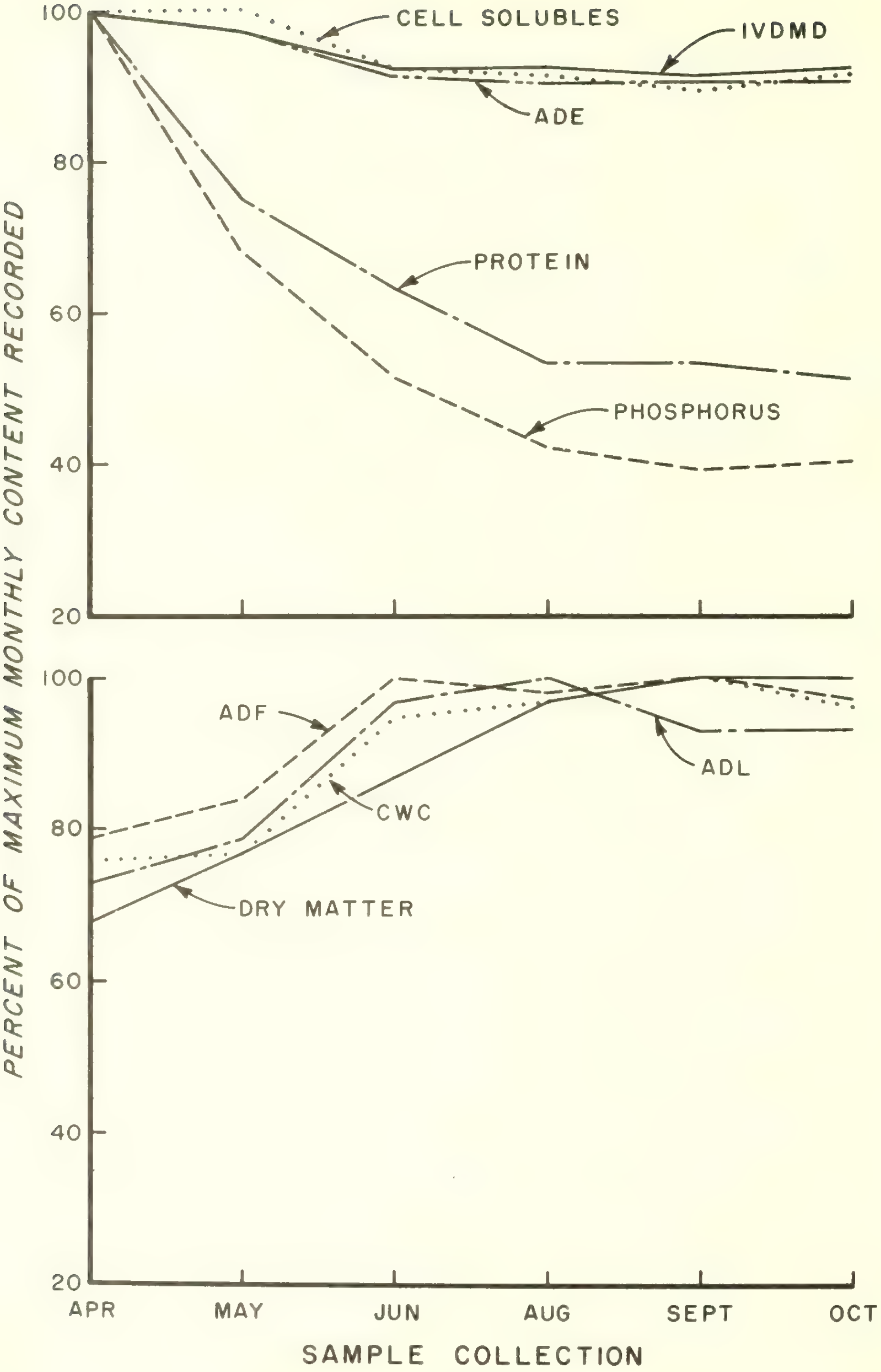

Figure 1.—*Mean nutrient composition and dry-matter digestibility of leaves of three browse species in east Texas prior to leaf abscission from deciduous species.*

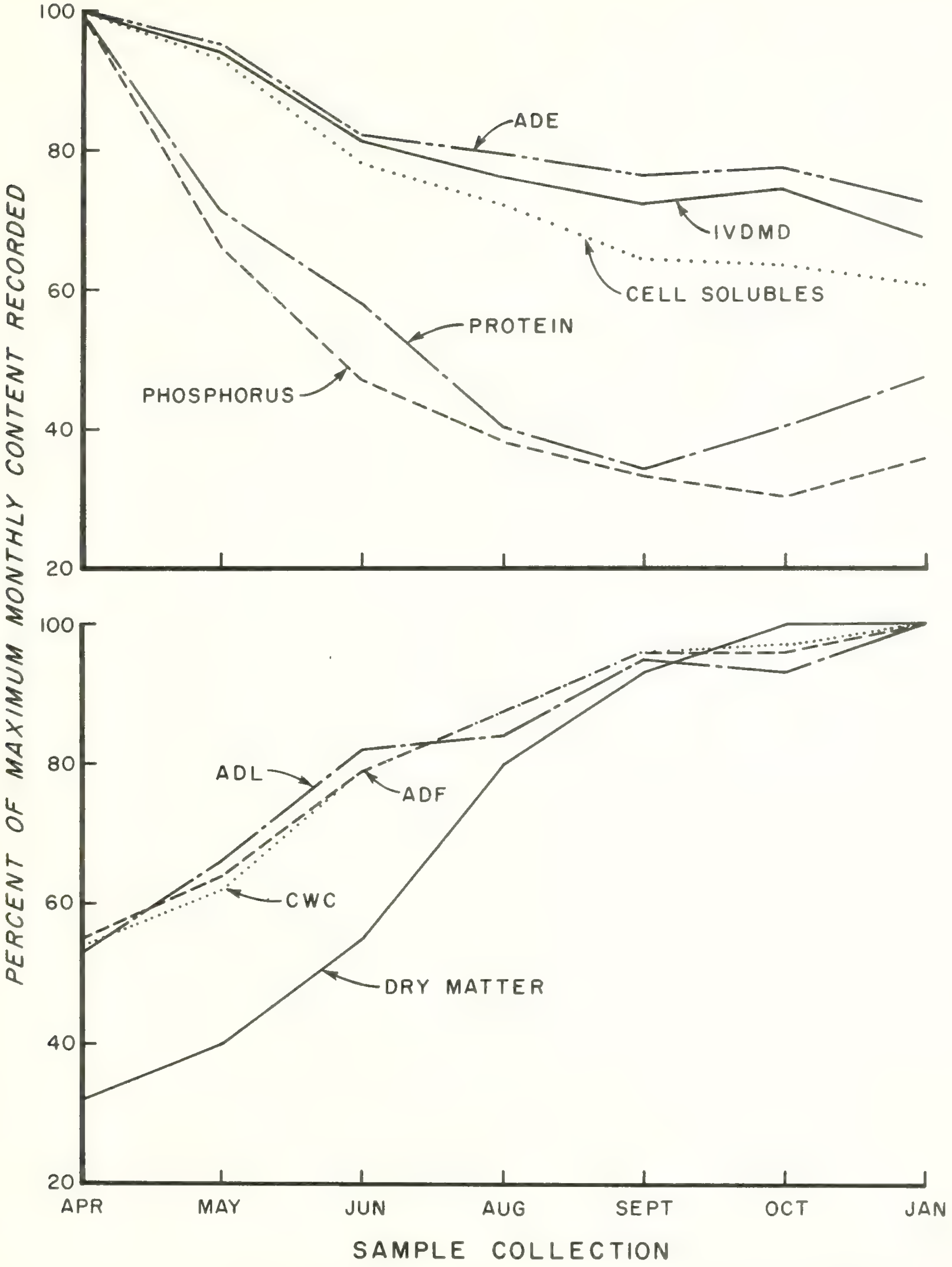

Figure 2.—*Mean nutrient composition and dry-matter digestibility of twig tips of three browse species in east* Texas.

Dry-Matter Digestibility

In vivo dry-matter digestibility (IVDMD) of leaf tissues was closely associated with growth activity and nutrient composition (table 1). IVDMD also was highest when leaf succulence, protein, phosphorus, cell solubles, and ADE were highest in the spring—ranging from 57.1 percent for sassafras to 66.3 percent for Japanese honeysuckle. With the onset of hot weather and growth maturation fiber levels increased and digestibility of leaves declined, though the decrease was small.

Dry-matter digestibility was associated negatively with ligno-cellulose fractions in the cell walls of leaf tissues at all seasons. Significant linear correlations ranged from r = − 0.45 for CWC in spring and summer to r = − 0.94 for ADF in winter. Digestibility of leaves remained relatively high throughout the summer and autumn, and averaged 80 percent of that in April (fig. 1).

The abscissed and weathered leaves of dogwood and sassafras were significantly lower in digestibility than were living leaf tissues. In January the weathered leaves of dogwood were 72 percent as digestible. Winter honeysuckle leaves were as digestible as spring leaves (table 1), varying only from 66.5 percent in April to 64.7 percent in January.

From spring through autumn the IVDMD ratings of dogwood and honeysuckle leaves were very similar. Leaf tissues of sassafras were least digestible of the 3 species throughout the year. In January the green leaves of honeysuckle were significantly higher in digestibility (64.7%) than leaves of dogwood (47.3%) and sassafra (28.8%)(table 2).

TWIG ANALYSES

Nutrient Composition

Spring.—Twig tips were most succulent in April. Dry matter averaged about 18 percent of the fresh tissue weight (table 3). Protein, phosphorus, and cell soluble fractions were highest whereas CWC, ADF, and ADL levels were lowest during the period of rapid twig elongation. By mid-May, as growth slowed and twig dry matter increased the protein content declined to 71 percent, phosphorus to 66 percent, and cell solubles to 93 percent of the April highs (fig. 2). CWC, ADF, and ADL increased significantly in all species. Apparent digestible energy varied little from April to May and was at a yearly high in the spring twigs. Gross caloric values of twigs varied little throughout the year. In spring and at other seasons, twig tips with high dry matter content tended to be relatively low in protein and phosphorus and tissues high in protein were also high in phosphorus. In autumn and winter protein and phosphorus content of twigs was negatively associated with fibrous cell wall fractions. Significant linear correlations ranged from r = − 0.78 to r = − 0.97.

In spring, honeysuckle leaders generally contained higher levels of protein, phosphorus and cell solubles and lower levels of ADE and fibrous cell wall fractions than twig tissues of dogwood and sassafras (table 4). Dogwood twigs were lowest in protein and phosphorus but were highest in ADE. Twig tips of sassafras were the most fibrous in spring. While the decline in protein and phosphorus from April to May was significant for all species, the percentage loss was appreciably greater for twig tips of dogwood and sassafras than for the more succulent leaders of honeysuckle. By mid-May the protein and phosphorus contents of dogwood and sassafras twig tips were exceptionally low with respect to the metabolic needs of deer (Blair and Epps 1969, Blair and Brunett 1977).

Summer-Winter.—Through early and midsummer the levels of protein, phosphorus, cell solubles and ADE continued dropping significantly. These nutrient losses were accompanied by increasing fiber deposition. By August crude protein averaged only 5.2 percent and phosphorus 0.11 percent. The level of these essential nutrients was down to 40 percent or less of the maximum content in the succulent spring tissues (fig. 2). Cell solubles and ADE dropped significantly, although less drastically in response to twig maturation, and by summer the respective fractions were 72 and 79 percent of the spring high. Calcium levels were higher in the mature growth of dogwood and honeysuckle than in the succulent spring growth, but calcium content did not vary significantly throughout the year in twig tips of sassafras. In spring and summer calcium was negatively associated with protein and phosphorus, but in autumn and winter high levels of calcium were associated with high levels of protein and phosphorus.

Fibrous fractions generally increased significantly from May to June as twig growth slowed.

Protein and phosphorus increased significantly in dogwood and sassafras from October to January. This might be expected among deciduous browses since leaves translocate nitrogen and phosphorus to twig tissues prior to leaf abscission in late autumn (Kramer and Kozlowski 1960). The level of these labile constituents did not change in honeysuckle leaders from autumn to winter.

Nutrient levels varied considerably between species from summer through winter (table 4). In early summer protein and phosphorus tended to be highest in honeysuckle leaders with little variation between dogwood and sassafras twigs. Species varied little during the remainder of summer and by autumn dogwood twigs were higher in protein and phosphorus than twigs of other species. In winter honeysuckle leaders contained significantly less of these nutrients than the other species. At all periods dogwood twigs generally contained the highest levels of calcium, ADE, and cell solubles while honeysuckle leaders usually were lowest in calcium and ADE yearlong and the lowest in cell solubles from midsummer through winter.

Sassafras tended to be more fibrous than either dogwood twigs or honeysuckle leaders from spring to August while honeysuckle leaders were more fibrous than twigs of the other species through winter.

With few exceptions, twig tips of all species were significantly lower than leaves in the percentage content of cell solubles, crude protein, phosphorus, calcium, gross energy, and ADE and higher in CWC, ADF, ADL and cellulose at all periods. Occasional exceptions were most prevalent in phosphorus and calcium levels when leaf and twig tissues did not differ significantly in content, especially during spring growth activity. Leaves also were more succulent than twigs from August to October.

Dry-Matter Digestibility

At all seasons the dry-matter digestibility of twig tissues was relatively low and, except for sassafras tissues in winter, twig tips were significantly less digestible than leaves. The IVDMD of all species declined significantly from spring to summer, and it remained low the remainder of the year. IVDMD was negatively related to CWC, ADF, ADL, and cellulose from summer through winter. Significant linear correlations ranged from r = − 0.66 for ADL in summer to r = − 0.85 for cellulose in autumn. It is apparent that the highly fibrous consistency of the mature twig tissues from summer through winter inhibits their metabolic usefulness to deer. With the slowing of growth activity in June, dry-matter digestibility of the fibrous twig tips and honeysuckle leaders remained below 49 percent. By mid-June the mean IVDMD was down to 81 percent of that in spring. Winter twigs and leaders averaged only 67 percent as digestible as spring tissues.

Twig tips of flowering dogwood generally were more digestible at all seasons than woody tissues from sassafras and honeysuckle (table 4) and dogwood twigs tended to be lower in fiber constituents than the other species from early summer through winter. Honeysuckle leaders tended to be the least digestible of the species, particularly from late summer through winter.

DISCUSSION AND CONCLUSIONS

The nutrient quality and metabolic usefulness of browse leaves and twig tips by deer and other herbivores is clearly related to tissue growth and maturation (Blair and Halls 1968, Blair and Epps 1969, Blair et al. 1977, Short et al. 1975). During the spring, the rapidly growing twigs and leaves are most succulent. The level of crude protein, phosphorus, highly digestible cell solubles, and apparent digestible energy is significantly higher in the new growth than at other periods of the year. Phosphorus content is relatively low in both leaves and twigs at all seasons and appears to be a limiting nutrient in forest habitats of the south. Fibrous cell wall fractions are lowest during rapid growth and tissues are at their highest level of metabolic usefulness to herbivores. Overall digestibility is the cumulative effect of the cell solubles, which ferment rapidly, and the slower digesting cellulose and hemicellulose (Van Soest 1970).

With the onset of higher ambient temperatures in June twig elongation slows, and by midsummer most tissues are essentially mature. Maturation brings about rapid and major changes in the forage value of tissues, more particularly that of twigs. Cell walls thicken and lignify and cell lumens diminish in volume (Leopold 1964). Lignin encrusts the cellulose in cell walls thereby reducing cellulose digestion by the rumen microflora.

Table 3. — *Seasonality of nutrient composition and digestibility of twig tips from 3 browse species collected in east Texas*

Chemical constituent	Species	Month collected						
		April	May	June	August	September	October	January
Dry matter[1]	COFL[4]	22.6 e[5]	28.2 d	34.4 c	42.8 b	49.1 a	48.4 a	50.1 a
	SAAL	17.4 f	23.6 e	30.8 d	46.0 c	51.2 b	59.0 a	58.7 a
	LOJA	13.4 e	14.2 e	25.2 d	43.7 c	53.2 b	58.3 a	57.0 a
Crude protein[2]	COFL	9.4 a	6.2 c	4.5 d	4.6 d	4.8 d	6.1 c	7.0 b
	SAAL	13.9 a	7.9 b	6.8 c	5.3 de	4.6 e	4.8 e	6.1 cd
	LOJA	15.6 a	13.6 b	11.1 c	5.7 d	4.0 f	4.6 ef	5.0 e
Phosphorus[2]	COFL	0.18 a	0.12 bc	0.08 e	0.09 de	0.09 de	0.10 cd	0.13 b
	SAAL	0.28 a	0.12 b	0.11 bc	0.10 bc	0.10 bc	0.08 c	0.10 bc
	LOJA	0.42 a	0.34 b	0.22 c	0.14 d	0.10 de	0.08 e	0.08 e
Calcium[2]	COFL	2.01 d	2.69 bc	2.74 bc	2.80 bc	2.99 ab	3.30 e	2.51 c
	SAAL	0.56 a	0.66 a	0.71 a	0.71 a	0.75 a	0.70 a	0.66 a
	LOJA	0.34 b	0.34 b	0.35 b	0.52 a	0.53 a	0.59 a	0.47 a
Crude fat[2]	COFL	7.6 a	6.1 bc	6.8 ab	4.9 cd	4.8 cd	5.5 bc	4.0 d
	SAAL	3.7 a	4.7 a	3.8 a	3.9 a	3.9 a	4.5 a	2.6 b
	LOJA	7.4 a	7.2 a	4.1 b	1.4 c	1.5 c	0.9 c	1.0 c
Cell solubles[2]	COFL	72.3 a	68.6 b	65.2 c	64.2 c	63.0 c	63.1 c	58.7 d
	SAAL	56.5 a	49.8 b	39.7 cd	41.2 c	36.7 de	35.5 e	36.2 e
	LOJA	76.8 a	72.2 b	56.0 c	42.1 d	31.4 e	30.2 e	29.2 e
CWC[2]	COFL	27.7 d	31.4 c	34.8 b	35.8 b	37.0 b	36.9 b	41.3 a
	SAAL	43.5 e	50.2 d	60.3 bc	58.8 c	63.3 ab	64.5 a	63.8 a
	LOJA	23.2 e	27.8 d	44.0 c	57.9 b	68.6 a	69.8 a	70.8 a
ADF[2]	COFL	24.3 d	27.4 c	30.5 b	29.8 bc	30.6 b	30.2 b	35.9 a
	SAAL	35.8 c	41.3 b	48.4 a	47.0 a	49.5 a	49.3 a	49.3 a
	LOJA	17.0 e	21.6 d	32.2 c	44.9 b	54.2 a	54.3 a	54.8 a
ADL[2]	COFL	7.1 d	8.6 c	9.8 b	9.8 b	9.5 b	10.0 b	12.0 a
	SAAL	14.3 b	18.2 a	18.5 a	17.8 a	19.5 a	18.5 a	19.3 a
	LOJA	5.4 e	6.7 d	13.3 c	14.8 b	19.2 a	18.8 a	19.4 a
Hemicellulose[2]	COFL	3.4 a	4.0 a	4.3 a	6.0 a	6.3 a	6.7 a	5.4 a
	SAAL	7.7 c	8.9 bc	11.9 ab	11.8 ab	13.7 a	15.2 a	14.5 a
	LOJA	6.2 d	6.2 d	11.8 c	13.1 bc	14.4 abc	15.5 ab	15.9 a
Cellulose[2]	COFL	17.3 c	18.8 bc	20.7 b	20.0 b	21.1 b	20.1 b	23.9 a
	SAAL	21.5 b	23.1 b	29.9 a	29.2 a	30.1 a	30.8 a	29.9 a
	LOJA	11.6 c	14.9 c	24.2 b	30.1 a	35.1 a	35.4 a	35.5 a
GE[3]	COFL	4505 b	4615 b	4597 b	4845 a	4988 a	4870 a	5028 a
	SAAL	4765 a	4813 a	4869 a	4861 a	4841 a	4797 a	4949 a
	LOJA	4553 a	4561 a	4592 a	4653 a	4693 a	4663 a	4758 a

Table 3. — *Seasonality of nutrient composition and digestibility of twig tips from 3 browse species collected in east Texas—Continued*

Chemical constituent	Species	Month collected						
		April	May	June	August	September	October	January
ADE[3]	COFL	2566 a	2556 a	2149 bc	2237 b	2263 b	2311 b	2052 c
	SAAL	2403 a	2227 a	1939 b	1960 b	1846 b	1967 b	1823 b
	LOJA	2273 a	2105 a	1856 b	1544 c	1404 c	1298 c	1315 c
IVDMD[2]	COFL	58.2 a	56.6 a	47.9 b	47.3 b	46.5 b	48.6 b	41.9 c
	SAAL	51.6 a	47.4 a	40.9 b	41.4 b	39.2 b	42.1 b	37.9 b
	LOJA	51.1 a	47.3 a	41.5 b	34.2 c	30.9 c	28.8 c	28.6 c

[1] Percent of fresh weight.
[2] Percent of dry weight.
[3] cal/gm.
[4] COFL = Cornus florida.
SAAL = Sassafras albidum.
LOJA = Lonicera japonica.
[5] Monthly values for each species (row) that are followed by a common letter do not differ significantly ($P > 0.05$).

Highly digestible cell contents are concurrently reduced. With increased ligno-cellulose deposition and reduced cell solubles the nutritive quality and metabolic usefulness of tissues diminish. With maturation, leaves generally maintain their nutrient quality and metabolic usefulness at a considerably higher level than woody twig tissues. The increased deposition of fiber fractions in the cell walls of twigs generally limits the usefulness of these tissues to the dietary regime of deer from early summer until growth resumes the following spring (Short et al. 1974, Short et al. 1972). Deer possess a small rumen volume and have high metabolic requirements, suggesting that they cannot digest fibrous tissues rapidly enough to subsist on high-fiber forages (Short 1963). Nondigestible acid detergent lignin, which includes aliphatic cutin and silica, constitutes varying proportions of the cell wall structure. Cutin is believed to be extremely resistant to microbial degradation in the rumen, hence along with silica and lignin, it inhibits nutritive value (Van Soest 1970).

Fresh leaves of palatable browses are generally higher in quality and dry-matter digestibility than twigs, particularly from growth maturation in early summer to leaf abscission in late autumn (Blair and Epps 1969, Short et al. 1975, Blair and Brunett 1977, Short et al. 1973). As nutrients decline and fiber constituents increase with twig maturation, leaves become a major source of nutrition for ruminants and are readily ingested by deer in the southern forest habitat (Blair and Brunett 1980, Harlow et al. 1975). Leaves of evergreen and tardily deciduous broadleaved browses are important as a readily accessible nutrient pool in late autumn and winter when nutritious foods are at a minimum.

Nutrient content and metabolic usefulness of specific plant tissues vary appreciably between species within a particular season (Blair and Epps 1969, Short et al. 1975). In assessing and defining the nutrient base composited from food items in a forested habitat, species composition should be considered fully.

Table 4. — *Monthly ranking*[1] *and statistical differences*[2] *of twig tips of browse species for important nutrient attributes and dry-matter digestibility*

Month	Crude protein	Phos-phorus	Calcium	ADE	Cell solubles	CWC	ADF	ADL	IVDMD
April	LOJA a	LOJA a	COFL a	COFL a	LOJA a	SAAL a	SAAL a	SAAL a	COFL a
	SAAL b	SAAL b	SAAL b	SAAL b	COFL b	COFL b	COFL b	COFL b	SAAL b
	COFL c	COFL c	LOJA c	LOJA b	SAAL c	LOJA c	LOJA c	LOJA c	LOJA b
May	LOJA a	LOJA a	COFL a	COFL a	LOJA a	SAAL a	SAAL a	SAAL a	COFL a
	SAAL b	SAAL b	SAAL b	SAAL b	COFL a	COFL b	COFL b	COFL b	SAAL b
	COFL c	COFL b	LOJA c	LOJA c	SAAL b	LOJA b	LOJA c	LOJA b	LOJA b
June	LOJA a	LOJA a	COFL a	COFL a	COFL a	SAAL a	SAAL a	SAAL a	COFL a
	SAAL b	SAAL b	SAAL b	SAAL b	LOJA b	LOJA b	LOJA b	LOJA b	LOJA b
	COFL c	COFL b	LOJA c	LOJA c	SAAL c	COFL c	COFL b	COFL c	SAAL b
August	LOJA a	LOJA a	COFL a	COFL a	COFL a	SAAL a	SAAL a	SAAL a	COFL a
	SAAL a	SAAL b	SAAL b	SAAL b	LOJA b	LOJA a	LOJA b	LOJA c	SAAL a
	COFL a	COFL b	LOJA c	LOJA c	SAAL b	COFL b	COFL c	COFL b	LOJA a
September	COFL a	SAAL a	COFL a	COFL a	COFL a	LOJA a	LOJA a	SAAL a	COFL a
	SAAL ab	LOJA a	SAAL b	SAAL b	SAAL b	SAAL b	SAAL b	LOJA a	SAAL b
	LOJA b	COFL a	LOJA b	LOJA c	LOJA c	COFL c	COFL c	COFL b	LOJA c
October	COFL a	COFL a	COFL a	COFL a	COFL a	LOJA a	LOJA a	LOJA a	COFL a
	SAAL b	LOJA b	SAAL b	SAAL b	SAAL b	SAAL b	SAAL b	SAAL a	SAAL b
	LOJA b	SAAL b	LOJA b	LOJA c	LOJA c	COFL c	COFL c	COFL b	LOJA c
January	COFL a	COFL a	COFL a	COFL a	COFL a	LOJA a	LOJA a	LOJA a	COFL a
	SAAL b	SAAL b	SAAL b	SAAL a	SAAL b	SAAL b	SAAL b	SAAL a	SAAL a
	LOJA c	LOJA c	LOJA b	LOJA b	LOJA c	COFL c	COFL c	COFL b	LOJA b

[1] Species ranked by descending order of magnitude for each specific nutrient attribute, based on values given in table 3.

[2] Species within a monthly group for each chemical constituent that are followed by a common letter are not statistically different ($P > 0.05$).

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Presents findings on seasonal variations in nutrient quality and metabolic usefulness of leaves and twig tips of three browse species for deer.

Additional keywords: Forage nutrients, forage quality, *in vitro* microdigestion, woody forage, deer foods, ruminants, browse.

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Spacing Trial of *Pinus caribaea* var. *hondurensis*

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and
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An Institute of Tropical Forestry Publication

Southern
Forest
Experiment
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SUMMARY

Pinus caribaea var. *hondurensis* is widely planted for its fast growth and versatile wood. Trials were begun on this species at four sites in Puerto Rico in the early 1960's to test which spacing would most rapidly produce stems suited for a wide range of products. Growth in height and diameter equaled that observed in other tropical countries where this pine variety is planted, and exceeded growth of temperate zone pine by far. Wood specific gravity averaged 0.48, and yields of over 45 m^3/ha/year were not uncommon. A spacing between 7 × 7 and 10 × 10 ft would produce fairly large stems in a short rotation. Closer or wider spacing may be desired depending on the end product sought.

This study was done in cooperation with the University of Puerto Rico.

1980

Spacing Trial of *Pinus caribaea* var. *hondurensis*

J. L. Whitmore and L. H. Liegel

INTRODUCTION

Pinus caribaea is native to Central America, Cuba, and the Bahamas. The Central American variety, *P. caribaea* var. *hondurensis* (Honduras pine), is now widely planted throughout the American, Asian, and African tropics and subtropics because it grows fast and its wood is more versatile than that of nonconifers. Of the three varieties of this species, Honduras pine is the most productive over a wide range of sites throughout the tropics and subtropics below 2700 ft (818 m). Many wood-importing nations have turned to plantations of Honduras pine to alleviate balance of payment problems.

Spacing trials for Honduras pine were begun at four sites in Puerto Rico in the early 1960's after preliminary tests showed high initial survival and good growth rates. The objectives were to (1) determine which spacing would produce trees at least 5 inches (12.7 cm) in diameter in the shortest time, (2) find the age when trees began to compete with each other within various spacings, (3) evaluate the effect of that competition, and (4) select spacing regimes best suited to produce different wood products for local markets. This initial report summarizes height, diameter, wood specific gravity, and volume growth results at ages 11.5 to 13.6 years.

All four sites are in the mountainous uplands, with elevations between 990 and 1700 ft (300 and 520 m). They receive 80 inches (2000 mm) or more of rainfall, well distributed throughout the year (table 1). At Utuado, near Caonillas Lake, the mean annual temperature is 75 to 79°F (24 to 26°C); at the other three sites it is 72 to 75°F (22 to 24°C). Slopes are variable, being steepest at the Utuado site (fig. 1).

At the Caracoles and Guzmán sites, within the Caribbean National Forest, soils are Los Guineos clay. They are deep, very acid (pH 4.4), and only moderately permeable, with clay amounts ranging from 38 percent at the surface to 56 percent in the lower subhorizons. The Guzmán site has inclusions of the old Catalina clay series, which is an Oxisol. Utuado clay loam predominates at the Utuado site.

Table 1. – *Site and outplant data for* Pinus caribaea *var.* hondurensis *spacing trials in Puerto Rico*

	Sites			
	Guzmán	Caracoles	Lares	Utuado
Outplant date	1962.9	1961.7	1963.8	1962.8
Elevation				
(ft)	1090	1715	1385	990
(m)	330	520	420	300
Precipitation[1]				
(in)	96	88	98	80
(mm)	2400	2200	2460	2000
Soils[2]	Epiaquic Tropohumult	Epiaquic Tropohumult	Typic Dystropept	Typic Humitropept
Soil Series	Los Guineos Clay	Los Guineos Clay	Anones Clay	Utuado Clay Loam
Slope (%)	0–15	10–35	0–40	10–80
Life Zone	Subtropical wet forest	Subtropical wet forest	Subtropical wet forest	Subtropical wet forest

[1] From Calvesbert, R. J. 1970.

[2] Based on USDA Soil Conservation Service, 1975.

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It is derived from granitic rock and is relatively shallow, the C horizon occurring at about 2 ft (60 cm). The lower horizons have loamy to sandy loam textures. In all horizons, pH is very strongly acid. At Lares, soils are Anones clay loam; they are well drained, strongly acid, and derived from highly weathered, pinkish, volcanic saprolite material.

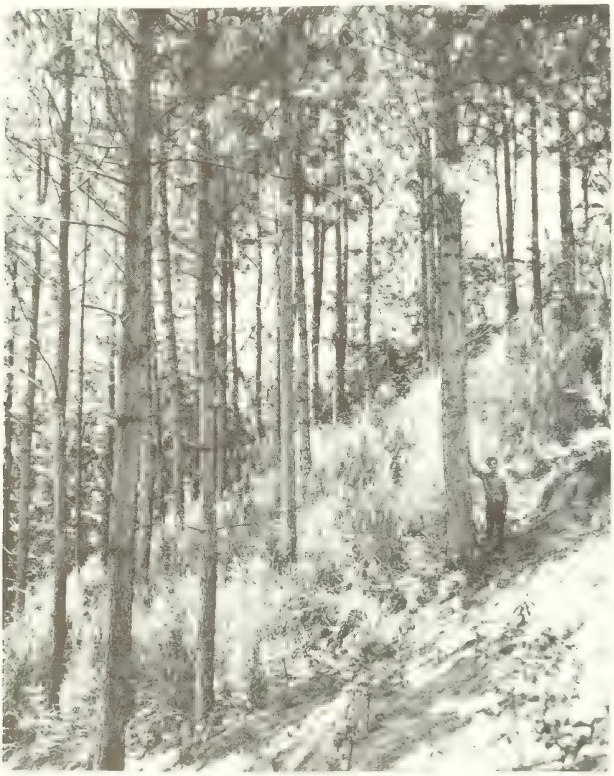

Figure 1. – Pinus caribaea *var.* hondurensis *planted at Utuado, the steepest site. Trees are 12.5 years old; spacing is 14-ft (4.3 m).*

METHODS

Triangular spacing, although more time-consuming to install than square spacing, was used because it allowed us to have more stems on each land unit. Each tree rested in the center of a hexagon where it had growing space equal to that of adjacent trees. With triangular spacings of 5, 7, 10, and 14 ft, the area occupied by each tree doubles between successive spacings (table 2).

Four points are adequate to define growth curve relationships. Based on Craib's (1947) work, we thought optimum spacing was somewhere between 7 and 10 ft. Four spacings were chosen to include this range and extremes thought to be too wide or too close.

Plots of 60 trees for each spacing were replicated twice at all sites. This design was a compromise between the high cost of plot establishment and maintenance and the minimum number of individuals needed to characterize spacing and site interactions. Twelve trees were designated as interior measurement trees; the other 48 were called exterior or surround trees. To avoid edge effect, we based our data on measurements of the 12 interior trees only. Data from both replications at each site were combined and then extrapolated to a per acre basis. Results were interpreted by analysis of variance and Duncan's new multiple range test, with stated significance differences tested at the 0.05 level.

Seedlings were grown at the Institute of Tropical Forestry nursery in polyethylene bags and were 5 to 7 months old when outplanted. Seed used came from Belize: Mountain Pine Ridge (1800 to 2300 ft; 545 to 697 m) for Caracoles and Stann Creek (near sea level) for Guzmán. Seed origin for the Utuado and Lares sites is not known, but probably was Mountain Pine Ridge, the most commonly planted seed source in Puerto Rico in the early 1960's.

All sites were hand cleared with machetes and bow saws. Caracoles and Guzmán had secondary forest; Utuado had brush and native grass; Lares had low brush and abandoned coffee bushes. Cleaned material was burned on the site. Planting holes were dug with a pick.

Weed growth was excessive at all sites for the first 5 years. When plots were less than 2 years old, weeding was done by hand with machetes or hoes. From age 2 to 5, weeding was done mostly by hand, but herbicides were also applied. Thereafter, weeding was done with machetes as needed.

Plot measurements were made in March and April of 1975 when tree age varied from 11.5 to 13.6 years.[1] Heights were measured with an Haga altimeter and diameters at breast height with a metal diameter tape.

Total cubic foot volumes were calculated from interior tree mean heights, outside bark diameters, and a Surinam volume table for *P. caribaea* var. *hondurensis* (Voorhoeve, n.d.). Volume and yield tables for Honduras pine in Puerto Rico do not exist. We selected the Surinam table because it brackets well the plot heights and diameters measured in this trial. Surinam receives 79 to 95 inches (2000 to 2400 mm) of annual rainfall and has a humid climate somewhat similar to that in Puerto Rico; mean temperatures there range from 72° to 82°F (22° to 28°C). The principal life zone in Surinam is tropical moist as compared to subtropical wet and lower montane wet (Ewel and Whitmore 1973) for the Puerto Rico sites.

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[1] Trials were established over a 2-year period. Decimal fractions describe age at each site.

How spacing affected wood quality was estimated from specific gravities of whole-core 12-mm samples taken at breast height. Calculations were based on ovendry weight and green volume.

Table 2. — *Number of trees per acre and amount of growing space per tree under square (S) and triangular (T) spacings*

Spacings		Number per acre		Area per tree (ft²)	
ft	*m*	*S*	*T*	*S*	*T*
5	1.5	1742	2012	25	22
7	2.1	889	1027	49	42
10	3.0	436	503	100	87
14	4.3	222	257	196	169

RESULTS AND DISCUSSION

Survival

At all sites survival was good and was not related to spacing. The mean survival for all sites was 88 percent (table 3). The widest survival range was 71 to 100 percent at Utuado; the lowest was 79 to 88 percent at Caracoles. Low survival in the 5-ft spacing at Utuado was due to localized soil erosion and slippage around plot trees. With weakened root systems, the affected trees eventually fell over.

Although other researchers have found increasing mortality from wide to close spacing, we did not see this trend in the Puerto Rico trials. For the ages reported, competition-induced mortality had not yet developed. Apparently Honduras pine can survive at close spacing even through age 13.6. We have seen good survival of Honduras pine in other local plantings also, up to 16 years old, where square spacings used were 5 × 5 and 6 × 6 ft (1.5 × 1.5 and 1.8 × 1.8 m).

Height Growth

Spacing affected height growth at all sites except Guzmán (fig. 2, table 4). At Utuado and Lares, total height and mean annual height increment (MAIHT) at 5-ft spacing was significantly less than that at 10- and 14-ft spacings. The differences in height growth between 5- and 7-ft spacings at these two sites were not significant. Differences in total height and MAIHT between 10- and 14-ft spacings were not significant at any site. We found slightly different trends after combining and analyzing pooled data for all trials: total height and MAIHT of the 5-ft spacings were significantly lower than those at 7 ft; MAIHT's for the 5- and 7-ft spacings were significantly lower than the MAIHT of the 10- and 14-ft spacings.

Analysis of pooled data showed that site also affected MAIHT growth. For example, at the 14 ft spacings MAIHT was 6.2 ft (1.9 m) for Utuado, 6.4 ft (2.0 m) for Lares, 4.5 ft (1.4 m) for Caracoles, and 5.0 ft (1.5 m) for Guzmán (fig. 2).

Mean annual height growth ranged from 3.8 ft (1.2 m) per year in the 5-ft spacing at Caracoles to 6.4 ft (2.0 m) per year in the 14-ft spacing at Lares. The largest difference in mean annual rates between spacings at any site was 2.2 ft (0.7 m) per year at Utuado. Growth at Guzmán may have been depressed because of Oxisol inclusions at that site.

The general trend in the Puerto Rico trials has been for wider spacings to produce taller trees (table 4). However, the world literature offers conflicting views on how spacing influences height growth. The discrepancies may be due to the various ways of expressing height growth in assessment reports or varying abilities of different species to survive under crowded growing conditions. The age at which growth assessments are made is also critical and can affect interpretations of spacing influence on height growth. Many early spacing studies were limited to close spacings, usually no greater than 6 or 8 ft (1.8 or 2.4 m). At these spacings most species will have severe competition and reduced growth if left unthinned.

Diameter Growth

Mean diameters increased progressively from narrow to wider spacings at all sites (fig. 3). Diameters at the 14-ft spacings were 1.6 to 2.5 times greater than those at the 5-ft spacings. Mean annual diameter increments (MAID) ranged from 0.4 to 1.0 inches (1.0 to 2.5 cm). At all sites, MAID's for 5- and 7-ft spacings were not significantly different. Except at Guzmán, MAID's for the 14-ft spacings were significantly greater than those for the 10-ft spacings; MAID's for both the 10- and 14-ft spacings were significantly higher than those of the 5- and 7-ft spacings. At Guzmán MAID's at 14 ft were

Table 3. – *Age, survival, and growth data summaries for triangular spacing trials of* Pinus caribaea *in Puerto Rico. Based on measurement of the 12-tree interior plots*

Site	Age	Spacing	Survival	Basal Area				Volume			
	years	*feet*	*percent*	Total		Mean annual increment		Total		Mean annual increment	
				ft^2/acre	m^2/ha	ft^2/acre	m^2/ha	ft^3/acre	m^3/ha	ft^3/acre	m^3/ha
Caracoles	13.6	5	83	381	87	28.0	6.4	11,477	803	844	59
		7	79	259	60	19.0	4.4	8,257	578	607	42
		10	88	247	57	18.2	4.2	7,531	527	554	39
		14	79	163	37	12.0	2.7	5,238	367	385	27
			$\bar{x}$ = 82								
Utuado	12.5	5	71	260	60	20.8	4.8	7,199	504	576	40
		7	100	278	64	22.2	5.1	8,291	580	663	46
		10	100	206	47	16.5	3.8	7,310	512	585	41
		14	92	170	39	13.6	3.1	4,715	330	377	26
			$\bar{x}$ = 91								
Guzmán	12.3	5	71	311	71	25.3	5.8	9,322	646	751	53
		7	96	282	65	22.9	5.3	8,518	596	693	48
		10	88	205	47	16.7	3.8	6,470	453	526	37
		14	83	125	29	10.2	2.4	3,827	268	311	22
			$\bar{x}$ = 84								
Lares	11.5	5	96	311	71	27.0	6.2	8,988	629	782	55
		7	96	268	62	23.3	5.4	8,770	614	763	53
		10	88	225	52	19.6	4.5	8,130	569	707	49
		14	100	193	44	16.8	3.8	6,946	486	604	42
			$\bar{x}$ = 95								

greater than those at 5 and 7 ft but not greater than those at 10 ft. When pooled data were used, MAID's were significantly different at all spacings and increased from narrow to wider spacings, but the effect of location on MAID was not significant.

Basal Area and Volume Growth

Both basal area and volume growth decreased as spacing increased (table 3). Highest and lowest total basal areas were 381 ft^2 per acre (87 m^2 per ha) at the 5-ft spacing at Caracoles and 125 ft^2 per acre (29 m^2 per ha) at the 14-ft spacing at Guzmán. The range in mean annual basal area increment (MAIBA) was 10.2 to 28.0 ft^2 per acre per year (2.4 to 6.4 m^2 per ha per year); within site differences ranged from 8.6 to 16.0 ft^2 per acre (2.0 to 3.7 m^2 per ha). Analyzing data for individual sites, we found that spacing influenced MAIBA's only at Guzmán where they were significantly less at the 14-ft than at the 5-ft spacing. Using pooled data, we found that (1) the MAIBA's at the 14-ft spacings were significantly lower than those at the 5- and 7-ft spacings, (2) the MAIBA's at the 10-ft spacing were significantly lower than those at the 5-ft, and (3) location did not affect MAIBA's. Significant differences found after pooling measurement data from all sites emphasize the importance of replicating any research study within a given site and across several sites.

Total and mean annual cubic foot volume increments (MAIV), like total basal area, were always greatest at the closest spacings, except at Utuado (table 3). The discrepancy at Utuado was probably caused by high mortality in the 5-ft spacing plot. The largest MAIV was 9.4 rough cords per acre per year (59 m^3 per ha per year) at the 5-ft spacing at Caracoles; the smallest was 3.5 rough cords per acre per year (22 m^3 per ha per year) at the 14-ft spacing at Guzmán. A rough cord is estimated at 90 ft^3 overbark.

Total basal area and total volume figures for Honduras pine in the Puerto Rico trials and corresponding MAIBA and MAIV rates are quite high if compared to rates from similarly spaced, unthinned stands of slash and loblolly pine. In many instances growth and volume increments are almost double for Honduras pine. These rates from Puerto Rico are at least as good as rates for Honduras pine reported in other countries (Cooling 1958, Cromer and Pawsey 1957, Faber et al. 1975, Lamb 1973, Luckoff 1964, New South Wales Forestry Commission 1972, Salazar 1976).

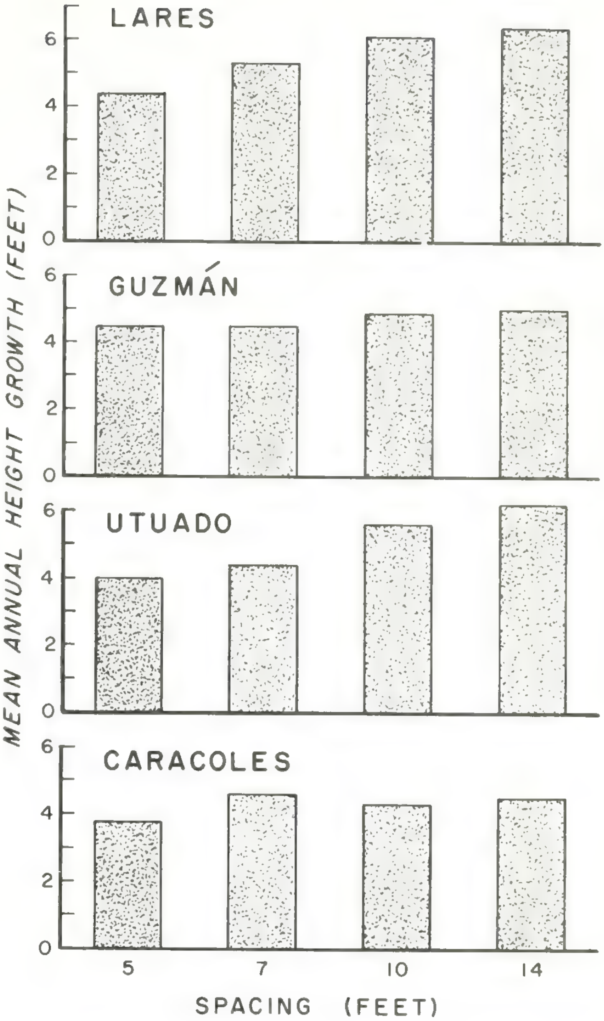

Figure 2 – *Mean annual height increment for triangular spacing trials of* Pinus caribaea *in Puerto Rico.*

Diameter Distributions

The number of trees per acre with d.b.h. ≥ 5 inches (12.7 cm) progressively decreased from 5- to 14-ft spacing except at Lares where the 7-ft spacing had the most (table 5). There were no trees ≥ 12 inches (30.5 cm) at 5- or 7-ft spacings except in the 7-ft spacing at Guzmán. At Utuado and Lares, the 14-ft spacing had more than 100 trees ≥ 12 inches, as did the 10-ft spacing at Caracoles.

Each of the four spacings produced trees ≥ 5 inches, but nearly all trees ≥ 12 inches d.b.h. were in the 10- and 14 ft spacings. In the 5-ft spacings, about 30 percent of the trees were < 5 inches; the youngest planting, at Lares, had 65 percent < 5 inches in the closest spacing. In the 5-ft spacings, diameters ≥ 5 inches ranged from 6 to 10 inches (15.2 to 25.4 cm). Mean heights by diameter classes are shown in table 4.

Wood Quality

Based on increment borer whole-core samples, the overall specific gravity was 0.48 for all sites, all spacings combined. The range was 0.41 to 0.55 (table 6). These results are particularly encouraging since disk or whole-tree averages would likely be even higher. Differences in specific gravity between sites were minor. Lowest specific gravity at three of the sites was in the 5-ft spacing. Field observations showed that wider spacings had greater taper and larger branch diameters, as would be expected.

CONCLUSIONS AND RECOMMENDATIONS

The four sites studied are productive pine sites and represent large, reforestable areas of Puerto Rico. Therefore, obtaining similar results on large tracts of land on the island should be practicable.

In plantations of Honduras pine one should expect annual height growth of about 4 to 6 ft (1.2 to 1.8 m), annual diameter growth of 0.4 to 1.0 inches (1.0 to 2.5 cm), and mean annual volume increments of 300 to 850 ft^3 per acre (21 to 59 m^3 per ha), depending on the spacing used. Spacing used will depend on the desired end product. Five-inch minimum diameters can be produced most economically in about 8 years at a spacing intermediate between 7-ft and 10-ft, i.e. at either 8- or 9-ft (2.4 or 2.7 m) triangular spacing. Using 7-ft spacing would increase the landowner's wait for a return by another 1 to 1.5 years. Wider spacings such as 8- or 9-ft would produce 70 to 90 percent of the total yields produced at a 5-ft spacing and would adequately protect the site from soil erosion.

Utility poles with minimum outside bark diameters of 8 inches (20.3 cm) can be produced best at 10-ft spacings. Waiting time would be about 12 years on the interior sandy clay loams, 11 years on deep acid clays like Los Guineos, and 10 years on young clay loam volcanic soils. Eight-inch minimum diameters for poles could be obtained quicker by using 14-ft spacing, but fewer crop trees would be produced.

If fence posts are the desired product, a 4-inch minimum diameter is reached at about 5.5 years at 10-ft spacing and at about 6.9 to 7.3 years at 7-ft spacing. Achieving a 5-inch minimum diameter takes about 7.0 to 7.3 years at 10-ft spacing. At 7-ft spacing it takes about 8.4 to 9.0 years. Using square

Table 4 – *Mean heights for diameter classes found in triangular spacing trials of* Pinus caribaea *in Puerto Rico. Based on measurement of the 12-tree interior plots*

			Diameter classes *inches*														
Site	Age	Spacing *ft*	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
			Mean heights *ft*														
Caracoles	13.6	5	25	28	38	49	60	69	61	79	72						
		7		41	38	60	64	63	67	70	75						
		10	8		39			59	55	58	63	65	67				
		14							56	64	64	62	61	72	61	81	87
Utuado	12.5	5		31	27	57	61	70	60								
		7		29	44	56	62	63	65	61	75	68					
		10			40	53	63	75	68	70	80	85					
		14							60		78	79	80	83			
Guzmán	12.3	5	25		47	53	64	64				69					
		7		31	42	51	52	65	62		80	72	68				
		10			47	47	50	50	68	63	74	68	71				
		14						58	56	61	63	64	68	69			
Lares	11.5	5	33	39	45	54	64	68				77					
		7	31	42	43	52	54	71	72	78	77						
		10		28			58	41	71	67	80	90	84			83	
		14					61		56	74	72	72	79	82	78		

Table 5. – *Diameter distributions for triangular spacing trials of* Pinus caribaea *in Puerto Rico (stems per acre). Based on measurement of the 12-tree interior plots*

Site	Age *years*	Spacing *triangular ft*	Diameter classes *inches*															Totals		
			2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Sum	≥ 5	≥12
Caracoles	13.6	5	84	251	84	585	251	84	84	167	84							1674	1255	0
		7		85	43	128	43	128	213	128	43							811	683	0
		10	21		21			21	84	21	105	63	105					441	399	105
		14							11	21	43	43	32	21	11	11	11	204	204	86
Utuado	12.5	5		336	168	336	336	84	168									1428	924	0
		7		171	128	128	171	128	85	128	43	43						1025	726	0
		10			21	42	63	84	84	84	42	84						504	483	0
		14							21		75	32	64	43				235	235	107
Guzmán	12.3	5	252		168	252	336	336				84						1428	1008	0
		7		86	128	171	128	257	86		43	43	43					985	771	43
		10			21	42	21	42	63	84	63	84	21					441	420	21
		14						32	21	32	64	21	11	32				213	213	43
Lares	11.5	5	84	420	756	84	420	84				84						1932	672	0
		7	43	43	43	257	86	214	171	86	43							986	857	0
		10		21			42	21	127	84	42	63	21			21		442	421	42
		14					11		21	21	21	64	43	54	21			256	256	118

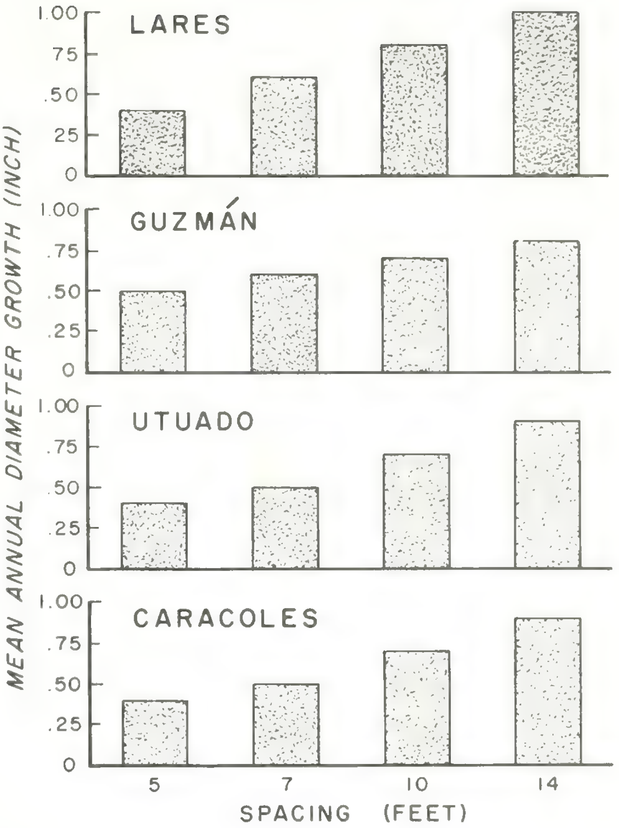

Figure 3 – ***Mean annual diameter increment for triangular spacing trials of*** Pinus caribaea ***in Puerto Rico.***

spacing might change these figures a bit, but because plantation establishment is easier with square spacing than with triangular, we recommend square spacing.

The high cost of land clearing and plantation establishment in Puerto Rico should also be considered when deciding upon spacing. Economic, cultural, and social trends make it difficult to obtain laborers in many parts of the island, for both establishment and maintenance work. Little money can be saved by land clearing when large spacings are used, since the entire planting site must be cleared for any spacing. However, wide spacings reduce the number of trees needed to reforest a site and, as a result, could reduce planting and maintenance costs considerably. Weed competition, which influences maintenance cost, should be about the same regardless of spacing during the early years when maintenance is necessary. However, while all four sites had profuse grass or brush understory in all spacings, vegetation was heaviest under the wider spacings.

Bennett (1963) presented results showing that total productivity of a soil could be realized over a fairly wide range of stockings. The Puerto Rico trials, except at Guzmán, support his findings. They also show that site quality can significantly affect height growth. Differences between Guzmán and the other sites may be due to use at Guzmán of a lowland seed source and the very low nutrient status of Catalina clay intrusions at that site.

High survival (over 80 percent) can be expected if plantations are well maintained and outplanting is done during the wet season. Cubic foot volumes are tentative, and should be recalculated once a local volume table is available. Specific gravities were higher than expected, indicating that a wide variety of wood products are possible from Honduras pine plantations. Once improved seed is available, pine productivity on sites in Puerto Rico, already quite satisfactory as shown by this study, can be expected to increase markedly.

Table 6.— *Wood specific gravity (dry weight over green volume) by site and spacing, at breast height. Each number (except overall means) is the mean of eight trees (four from each of two replicates) chosen randomly from the 12-tree inner plots. Samples were unstratified, representing the range from pith to cortex.*

Site	Spacing				
	5x5 ft	7x7 ft	10x10 ft	14x14 ft	Overall mean
Caracoles	0.41	0.47	0.54	0.51	0.48
Utuado	0.42	0.47	0.47	0.50	0.46
Guzmán	0.49	0.47	0.54	0.55	0.51
Lares	0.44	0.47	0.48	0.53	0.48
Overall mean	0.44	0.47	0.51	0.52	0.48

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